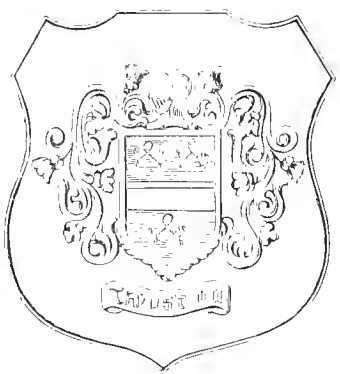
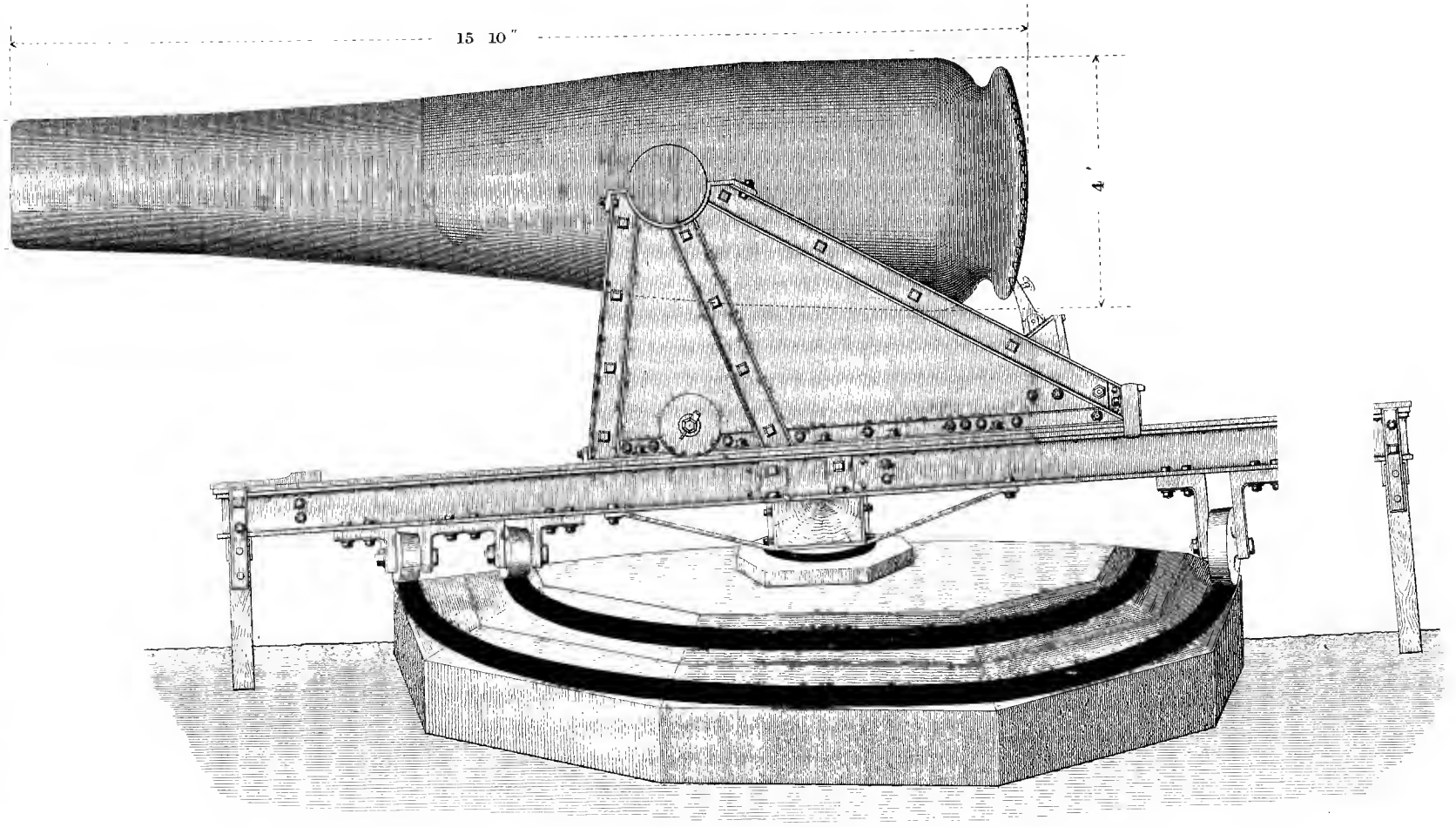
NOTES
ON
SEA-COAST DEFENCE

BARNARD.





THE FIFTEEN INCH GUN.

Weight 49100. lbs.

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NOTES

ON

SEA-COAST DEFENCE:

CONSISTING OF

SEA-COAST FORTIFICATION,

THE FIFTEEN-INCH GUN,

AND

CASEMATE EMBRASURES.

BY

MAJOR J. G. BARNARD,

U. S. CORPS OF ENGINEERS.

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1861.

TO

GENERAL JOSEPH G. TOTTEN,

CHIEF ENGINEER U. S. ARMY,

THESE PAGES ARE

Respectfully Inscribed.

CONTENTS.

THE march of invention and improvement in all the machinery of war has been so rapid, of late years, as to make necessary frequent scrutiny of all existing "systems," whether of military organization or construction, lest they should be found no longer adapted to their purposes.

Indeed, it is more common by those who would be regarded as illuminated by the new lights of the age to lay the charge of "obsolete" against such systems than to scrutinize their validity.

The existing system of American "Sea-coast "Defence" has been *always* a chosen subject with such. To examine whether it is still a safe reliance for the nation, and whether it is capable of opposing to new and probable means of attack new and sufficient counteracting agencies,—to ascertain, in fact, whether it has in itself a faculty of *adaptation* to the changes of the times, without which nothing old can long survive,—is the object of these "Notes."

SEA-COAST FORTIFICATION.

Sea-Coast Fortification.

It is well known that important steps have recently been taken in England towards the more perfect defence of the great maritime arsenals and dock-yards. No less a sum than some fifty millions of dollars has been appropriated by Parliament to the *immediate* construction of fortifications for Woolwich, Chatham, Sheerness, Dover, Portsmouth, Portland, Plymouth, and Pembroke.

Whether we consider this as but an *incidental* measure connected with the general defence of the country against the much-talked-of invasion by France, or whether we regard it as simply a step, now become necessary, for the security of those great establishments at which the proposed works are to be located, it is equally full of interest to those who have been concerned in the American system of defences. Indeed, it would seem as if England had waited until all

the changes of opposition had been rung by the critics of our system, to send us this, her practical answer, to such arguments as have been founded upon *her* example, and, at a period when she can no longer refrain from adopting a thorough system of coast defence, to give in her adhesion to the great principle upon which *our system* was founded forty-five years ago, and upon which it has undeviatingly been prosecuted. Barely twenty years have elapsed since the, then, highest military authority of the government—a man whose public services, military and civil, added much to the weight which his high position gave to his strictures upon our system of fortifications—asserted, in an official report,—

"1. That, for the defence of the coast, the chief "reliance should be on the navy."

"2. That, in preference to fortifications, floating "batteries should be introduced wherever they "can be used."

"3. That we are not in danger from large ex- "peditions, and, consequently,

"4. That the system of the Board of Engineers "comprises works which are unnecessarily large for "the purposes they have to fulfil."

Commodore Perry, a high authority, whose opinions have not wanted participators, especially among naval men, expressed, at a still more recent period (but eight years ago), his belief that *naval means* should be principally relied on for our defence, and enforced his opinions by the example of England:—

"Of all the coasts of Europe, that of Great "Britain is the least provided with fortifications; "and yet her soil has not been trodden by a suc- "cessful enemy since the conquest; solely pro- "tecting her military and naval arsenals by per- "fect and *well-garrisoned* works. She depends "mainly for defence of her coast upon her navy "and the warlike spirit of her yeomanry; and the "very absence of fortified works prevents a de- "ceitful reliance upon such defences, and keeps "alive the more gallant and more certain depend- "ence upon their own personal prowess."

Such opinions, though they are not *entirely* abandoned, have now so few supporters that it would be wasting ink and paper to quote them for confutation; but, at least, we may find in their history the ground for confirmed belief that the system which has thus outlived the adverse opinions of its ablest critics—even though a new class

has recently arisen, to announce the brilliant discovery, that all stone walls are but "crockery" against the newly-invented missiles which modern military science will hurl against them—is *still* the true one. So far from having become "antiquated" and "obsolete," the very nation whose exemption from its "chained monsters" has been so vauntingly cited, has at this recent date indorsed it, even to the extent of its "masonry casemated castles." We will let the British Commissioners state their own case.*

"During the wars in the early part of this cen-
"tury, when the strength of the Royal Navy had
"attained an extraordinary development, it was
"equal to the performance of all the duties im-
"posed upon it; but it appears doubtful to your
"Commissioners, having regard to the present state
"of continental navies, whether even a fleet of such
"magnitude as we then possessed would now be
"able to perform them all efficiently. A much
"larger proportion would be required for purely
"defensive purposes than previously, owing to the
"certainty with which the movements of fleets
"can be combined by the aid of steam, and the

* See Report of Commissioners appointed to consider the Defences of the United Kingdom, &c. London, 1860.

" rapidity with which a large force can be concen-
" trated at a given time on any point. Even if
" it were possible that a fleet sufficient to meet
" the emergency of a sudden naval combination
" against this country could be kept available, and
" fully manned in time of peace, such an applica-
" tion of the resources of the nation would lead
" to an outlay of the public revenue far exceeding
" the expenditure which would suffice for that ob-
" ject under other circumstances. The first cost
" would be very great, and the necessary expense
" for maintenance would be continual, involving
" the employment of a large additional number of
" trained seamen,—a class of men who can with
" difficulty be obtained, and who are necessarily
" the most costly of any branch of the military
" service, owing to the various qualifications re-
" quired of them. A periodical renewal of the
" entire fleet would, even under ordinary circum-
" stances, be requisite about every thirty years,
" without regard to those changes which are un-
" avoidably caused by the present transitional state
" of naval architecture, and the rapid progress of
" mechanical science, in which changes we are
" compelled to take the lead in order to maintain
" our maritime supremacy."

It is not strange, then, that the Commissioners have found it necessary to admit that a system of purely naval defence "is one which could not "be entirely relied upon at the present day, even "if England had no greater external interests to "protect than the countries which may be op-"posed to her."

To estimate fully the real importance of such conclusions, at this date, on the part of England, it is necessary to consider that our own system was inaugurated at a period when, compared with England—with *ourselves*, even, as we are now—we were a weak nation, with an extensive seaboard to defend against maritime attack. Even if the immense naval means of England had been a safe reliance (at that date) for her, the utter disparity of our own naval power would have made it unreliable *for us*. At best, the fact would have only raised the alternative whether, for *our* coast defence, we should create a navy (proportionally) as great as that of England, or whether we should resort to fortifications. We adopted the latter alternative; and we did so, not simply because we had not a large navy, but because we based our defensive system upon the broad principle that naval means were *not* the true means of *coast*

defence; that to give full efficiency, even, to our navy, and to set it free to fulfil its higher destiny of protecting abroad our rights and our commerce, and of extending the weight of our arms to the enemy's own shores, our cities and harbors *must be* defended by fortifications.

On the other hand, England, during the quarter-century's wars growing out of the French Revolution, had annihilated the navies of Europe; and the peace of 1815 found these nations, one and all, so exhausted, that her shores would have been safe, for a period at least, with neither fortifications nor extensive naval means. As years elapsed and the nations of the continent (France especially) recuperated, and ideas of new contests revived, there was yet much to give great security to the shores of England without giving any greatly increased development to her fortifications. Her navy had, still, greatly the preponderance; and if the narrowness of the channel seemed to give great facilities to France for a hostile descent, yet, in the days of sailing vessels, this circumstance was perhaps *more* than compensated by the ease with which the whole coast of France could be watched and every French port blockaded by the powerful navy of England.* The fact, there-

* Yet, to show how unreliable this species of defence is, even when

fore, that England has hitherto been able to do without very extensive works of sea-coast fortification,* is not an argument that fortifications are not, *per se*, the most reliable and the cheapest of all means of harbor defence.

But whatever argument might have been drawn from the example of England, in past years, she furnishes *now* the most striking example that could be offered to us of the truth of *our* fundamental principle, that the essential and true *basis* of coast defence is fortification. Through her Commissioners, she declares "That it would be very "unsafe to rely on the experience of former wars "in judging of this question. Since the peace of

there is every warning of a threatened invasion, and every possible defensive means which an immense navy affords is taken, witness the invasion of Ireland, in 1796, by Hoche. Three powerful fleets were on the lookout for this expedition, yet it got out unnoticed, and, after eight days' passage, landed 25,000 men at Bantry Bay (occupying three days in so doing). Of the forty-four vessels, only one was intercepted by the English squadron. Well does Allison say that the empire of the seas does not afford security against invasion.

* It would seem as if those who have referred so much to the example of England supposed she had never had fortifications at all. From the very earliest days of her maritime greatness she commenced fortifying her shores. Plymouth, Portsmouth, Dover, and other great ports, have not only been protected seaward by fortifications, but are enveloped in continuous enceintes for land defence, which date back to the 17th century. These works have, for the last forty years, been constantly *added to*, while almost a continuous range of Martello towers overlooks the waters of the channel.

" 1815, the state of naval warfare has been revolu-
" tionized. The introduction of steam may operate
" to our disadvantage in diminishing to some ex-
" tent the value of superior seamanship; the effi-
" cient blockade of an enemy's ports has become
" well nigh impossible; the practice of firing shells
" horizontally, and the enormous extent to which
" the power and accuracy of aim of artillery have
" been increased, lead to the conclusion that, after
" an action, even a victorious fleet would be more
" seriously crippled, and, therefore, a longer time
" unfit for service." And again they say, "Since
" the application of steam to the propulsion of
" vessels, we can no longer rely upon being able
" to prevent the landing of a hostile force in the
" country;" and, finally, after examining all *other* defensive means, they state their conclusion as follows:—

" Having carefully weighed the foregoing con-
" siderations, we are led to the opinion that neither
" our fleet, our standing army, nor our volunteer
" forces, nor even the three combined, can be re-
" lied on as sufficient in themselves for the secur-
" ity of the kingdom against foreign invasion.
" We, therefore, proceed to consider that part of

" our instructions which directs our attention espe-
" cially to fortifications." * * * *
* * * * "We are thus led to the
" conclusion, that by a judicious application of
" fortifications the means would be afforded of
" utilizing, in the highest degree, both our fleet
" and the regular army, and the forces which
" would be brought in aid of it; and, further,
" that without fortifications there is no mode of
" defence which can be proposed that would give
" the same amount of security to the country, and
" at the same time be so economical both in
" money and troops."

The Commissioners, having thus decided that a more extensive system of fortifications was necessary for the security of England, proceed to lay down the principles which should govern their location and extent. They are essentially identical with those adopted by our own engineers. They state that "The fortifications of this country " should be confined, chiefly, to the protection of " those vital points at which an enemy would " strike, and of harbors whose possession would " give him sure bases of operations in positions " favorable to his designs."

"There are also certain harbors which, although "not of sufficient consequence to be used by them- "selves as bases for extensive operations, would "nevertheless, afford an enemy, if he possessed "them, facilities for landing guns, horses, and "matériel; and at these it appears advisable to "have some degree of permanent defence, in order "to deny their use to him, and cause him some "delay by restricting his operations to the open "beach until he had succeeded in capturing the "defences. It is desirable, also, that works of de- "fence should be provided for our commercial "ports. The security of several of these would "be of the utmost moment to the trading interests "of the country; and others have a military value, "independent of their commercial importance; but "ports of this character are not subject to attacks "on a great scale, such as would be brought to "bear on the royal naval establishments. The "measures for their defence would be of compara- "tively small extent."

They regard the *dock-yards* as the vital points of coast defence, while places of mere commercial importance—even such as Liverpool—require less means of defence. But while the great dock-yards are considered as *vital points*—points which, in

view of the important consequences of their capture or destruction, would, *in themselves*, invite an attack in force—it is *London* which they consider the *true vital* point of England, in reference to French invasion. "There can be no doubt," they say, "that the main object of an enemy invading the "country would be to push for the capital, in the "hope that if he succeeded in obtaining command "of it, such a disaster would result in our buy- "ing him off upon any terms he might think it "expedient to exact." The Commissioners do not indeed take up directly the question of the defence of London, since it formed no part of their instructions to do so; but they consider the fortification of the coast—*i. e.*, the harbors and dock-yards—as, in itself, an indispensable step towards the defence of London.

We have no single place corresponding in all respects to London,—the *political* capital of the nation—the *commercial* capital of the *world.* But we *have* places which will be almost as truly the vital points of the war with a great maritime power as London is that of England.

In a paper on the "Dangers and Defences of New York," the writer attempted to show that in future all war of maritime powers against the United States will be directed against our great

sea ports, and *particularly* New York. The defence of New York is indeed, to us, though in a somewhat less degree, what that of London is to England. It may be said of New York, as of London, that if an enemy "succeeded in obtaining "command of it," even temporarily,—or, what would be nearly the same in its consequences, if he succeeded with his fleet in forcing the entrance to the harbor, and in bringing his guns to bear on the city, "such a disaster would result in our buy- "ing him off upon any terms he might think it "expedient to exact." Attacks upon other great sea-port towns, such as Boston or Philadelphia, might, indeed, be attended with results highly disastrous, but they would tell comparatively little upon the issues of the war. The difference is that between striking a limb and striking the heart, for New York is the true heart of our commerce—the center of our maritime resources; to strike *her* would be to paralyze *all* the limbs. As a powerful maritime enemy will select that point where the effect of his blows will be most disastrous; as, in proportion to the resistance he anticipates, he will prepare himself for the attack, we may be sure that New York would be the scene of repeated and terrible struggles, ceasing only to be renewed again as long as a war should last; un-

less, indeed, our defensive system is so impregnable as to make attacks hopeless. It was under such convictions that the following paragraph was written in the "Dangers and Defences:"

"The mere defence of the city against *ordi-*
" *nary fleets* is no longer the question; but, *through*
" *the defensive works to be here erected, the nation*
" *is to measure its strength against the most lavish*
" *use of the resources of a great maritime power,*
" *aided by all that modern science and mechanical*
" *ingenuity, in creating or inventing means of at-*
" *tack, can bring against them;* in short, in forti-
" fying New York, *we are really preparing the*
" *battle field on which the issue of future momentous*
" *contests is to be decided.*"

If, therefore, there is anything real and earnest in our *preparation* for war, it is New York that most urgently and speedily demands that the preparation shall be rendered complete. Let *her* be *completely* defended and we need fear little from efforts elsewhere. But, however complete our preparations *elsewhere* may be, we are yet exposed to all the worst consequences of a maritime attack until New York is made *impregnable.*

As to the *methods* of defence, we are not to

look to London, for that involves considerations of locality quite different from those that belong to New York. But we may turn to Portsmouth, with its external anchorage of Spithead, for an example having in its local characteristics analogy with New York, and as the greatest naval depot and dock-yard of England,—an importance to the national defence second only to that of London.

It has been stated that, although England has been so often cited as an example of reliance upon naval means alone for coast defence, she has *never* trusted the security of her great naval establishments nor more important harbors entirely to such means. The towns of Portsmouth and Portsea were, in the 17th century, surrounded by a continuous bastioned enceinte, while the entrance to the harbor and approaches are defended by works which have been constructed at different periods. Some of these last works are casemated—some open, or barbette batteries. So extensive are these works at the present moment that, so far as the "immediate defence of the entrance" or a landing on the adjacent shores is concerned, the Commissioners find that little more is needed.

The spacious external anchorage of Spithead (presenting much analogy to the Lower Bay of

New York), of vast importance to the navy of England, and a position from which the dock-yard can be bombarded, is entirely defenceless. This anchorage between the Isle of Wight and Portsmouth is too broad, and too far distant from the land, to be reached by shore batteries. Here, at the very heart of the naval opulence of England, one would think that if "naval means" were at all reliable or admissible such means would have been resorted to. That they are *not* reliable, unaided by forts, may be best judged by the fact that, for this defence, *five* "masonry casemated castles" are to be built on *shoals* covered by several fathoms of water, and the Commissioners "Recommend that "the more important of these works should be "built with three tiers of guns in casemates, with "guns and mortars on the roof. The adoption of "such a mode of construction will add consider-"ably to the amount of fire that can be brought "to bear on any point, and will give the upper tier "of guns command over the decks of the attack-"ing ships—an advantage which will be obtained "at a comparatively small addition to the total "cost of the work when the foundations have been "completed. These batteries should be built of "masonry, faced with hard granite; the embrasures "should be of wrought iron, and of as small dimen-

" sions as possible, compatible with the free work-
" ing of a gun."

One might almost think that an American engineer had penned the above paragraph, so truly are the principles which have governed us, *in similar cases*, adopted; not that we consider "ma-
" sonry casemated castles" of quadruple tiers of guns as absolutely the *best* way of arranging guns, but that in such localities, where space cannot be had, they are the best for the circumstances. The idea of "embrasures of wrought iron, and of as " small dimensions as possible," is evidently derived from our model embrasure, such as may be seen at Fort Richmond.

Such are the results at which English Commissioners have arrived, and their report has been generally approved by the British public, adopted, and funds to the amount of fifty millions of dollars, as before stated, voted in Parliament for the immediate execution of the works recommended, and the system of defences is now in the course of execution. Critics may scoff at it if they choose, but at least they cannot allege, as they sometimes do, in reference to *our* system, that it was devised before the days of steam—of rifle-cannon—of iron-clad floating batteries. All these things they are thoroughly acquainted with. They had, too, the

recent experience of the Russian war, in which the efficiency of Russian fortifications had been so thoroughly tested. The repulse of the attack of the allied fleet before Sebastopol, and the extraordinary paralysis with which the combined fleets of England and France—the mightiest naval armament the world ever saw, headed by the boastful Napier—were smitten at the sight of the "masonry casemated castles" of Cronstadt, were fresh in their recollection. They knew all that had been done and all that has been proposed to be done with "iron-clad floating batteries," and evidently were *not* impressed with the conviction that they were, *or even could be* made, a match for fortifications.*

It is flattering to the military pride of our nation—it is satisfactory to our own sense of security—to find that the principles of coast defence which we for the first time laid down nearly a half-century ago are, at this date, adopted by that nation whose immunity from coast defence has been so

* Not only can our masonry batteries be protected, *if it ever becomes necessary* (which I consider it far from being at the present time), by the same means which are resorted to for the floating structure; but we know that we can direct against these (so-called) *shot-proof structures* a shot which will stave in the sides, carry as much iron as she may on them consistently with floating. I allude to Captain Rodman's successful construction of a 15-inch gun which will doubtless soon be introduced into our fortifications.

long boasted, and that the *means* of defence resorted to are identical with those we have been and are still applying to our own coasts. Would that we could still further be an example in the *promptitude* with which we complete a system long since undertaken. Though we may not plead the urgency which the English nation feel in perfecting their defences, it is at least highly important that *that one point*—New York—upon which the stress of maritime war will surely fall, should be *promptly* made perfectly defensible.

Before closing this paper it will be profitable to turn back again to the criticisms or "objections" which have been raised at different periods. The quotation already made on a former page gives the objections of the head of the War Department —one of the then most prominent military authorities in the country. They are a full expression of the hostility of that day to the system.

It is somewhat amusing to find that at the present day the first two propositions (long since abandoned by naval officers* as untenable) are

* Of the numerous distinguished British naval officers (all of whom had seen service *against* fortifications either in the Black Sea or Baltic, or other of the remarkable actions of that kind in which England has been engaged) there was *not one* who would rely on "naval means" or "floating batteries" alone. *All* recommended fortifications.

now renounced by the very nation whose immunity from danger behind her floating walls has been so often appealed to,—the very nation, too, whose "naval means" surpass those of all the rest of the world,—and that some *recent critics* of our system take exactly the *reverse* position from the last propositions, and assert that we *are* "in danger "from large expeditions," and pronounce most of our works "weak and contracted," particularly on their land sides,—while still another class think that our forts need not even have a defensible front towards the land.

With the substantial proofs which we now have of the wisdom and foresight of those who, half a century since, inaugurated our system—of its entire adaptedness to our *present* circumstances, we can well afford to leave criticism to do as it has so repeatedly done,—confute itself.

THE FIFTEEN-INCH GUN.

The Fifteen-Inch Gun.

The fifteen-inch gun, now at Fort Monroe, was cast at the Fort-Pitt foundry of Messrs. Knapp, Rudd & Co. (Pittsburg), under the direction and after the method of Captain T. J. Rodman, of the ordnance corps, to whose perseverance, zeal, and laborious investigations the successful result is mainly due.

Its dimensions are as follows:

Total length of gun,	190	inches.
Length of calibre of bore,	156	"
Length of ellipsoidal chamber,	9	"
Total length of bore,	165	"
Maximum exterior diameter,	48	"
Distance between rimbases,	48	"
Diameter at muzzle,	25	"
Thickness of metal behind the chamber,	25	"
Do. at junction of bore with chamber,	16½	"
Do. at muzzle,	5	"
Weight of gun,	49,100	lbs.

The unprofessional reader may ask, "Why more "difficulty in making a gun of this calibre than a "smaller one?" So far as the mere casting of *so much metal* is concerned, there is none at all. But it is found, practically, that guns of large calibre, cast by the ordinary methods, have not the *requisite strength* to bear the strain to which they must be subjected in firing. This is mainly owing to the fact that melted iron *shrinks* in cooling, and that (when the mass is large) the process of solidifying is not simultaneous throughout the mass, but is progressive from the surface inwards. By the usual methods, guns are cast *solid* and then bored out. The effect of this solid casting is, that the outer shell first cools and becomes solid, while the interior is still liquid. As the interior cools it produces by its contraction a strong compression in the outer and first solidified portions. The outer, already solid crust, being unable to follow the contraction of the inner mass, the latter becomes solid in a state of high tension, and, when the mass is large, not infrequently forms flaws and cavities. So long as guns of small calibres only were used, the evils of this method did not exhibit themselves to such an extent as to prevent ordnance thus made from being perfectly serviceable. But even with

small calibres it is obvious that about the surface of the bore, where the greatest strength and greatest hardness is required, the metal is the least dense and the least hard of the whole mass; and it is owing to this fact that guns become so soon unserviceable, by the enlargement of the bore around the seat of the ball, after prolonged firing. Indeed, this enlargement is readily detected and measured (by delicate instruments especially adapted to the purpose), and is almost invariably found to have occurred in the best solid-cast guns after a few hundred rounds of firing. As the firing is prolonged, the enlargement of the bore is observed to progress; the state of compression (already mentioned) in which the cooling process leaves the outer crust of the gun actually *aids* the internal effort of the powder, and, after a certain number of rounds (from one to two thousand) with full charges, the gun bursts.

The greater the mass of the casting—that is, the greater the calibre of the intended gun—the greater are the irregularities of structural arrangement caused by this manner of casting, and the more inadequate does the gun become to resist the strain to which it must be subjected. Hence the (hitherto) practical limit to the calibre of cast-iron guns.

No nation in the world has succeeded in making *serviceable* guns of more than 10 inches calibre.*

Captain Rodman's method consists *especially* in casting the gun *hollow* instead of solid, and—by means of a current of water introduced into the core which forms the mould of the bore—cooling from the *interior*. To ensure the cooling shall be exclusively internal, the exterior of the mould is kept heated during the whole process. The effect of this is easily seen to be that the interior metal (immediately about the bore) solidifies *first*, and, as the more distant portions solidify, there is nothing to oppose their contraction; they, therefore, assume the solid state without causing those injurious strains in the metal caused by the old process. In reality, when the cooling is properly managed, the interior metal about the bore is in a state of *compression* and the exterior in a state of tension; exactly as theory shows it *should be* to get the *maximum strength* of the whole thickness of metal when subjected to internal strain. Not only this, but the metal about the bore first cooled and in constant contact with the cooling medium is, as it

* Dahlgren's guns for naval service are of 11 inches calibre. Though they will project a solid shot with light charges, their principal use is as a shell gun.

should be, the *hardest* and *densest.* By the *solid* casting process it has been shown that the results as to both these conditions—of tension and of hardness—were just the reverse. Hence the practical limit to increase of strength with thickness by that process.* These theoretical considerations have been fully confirmed by experiment. Several guns of smaller calibre were cast and subjected to severe tests previous to attempting so unusual a calibre. The 15-inch gun of which I now speak has been subjected, up to present date, to 350 rounds with full charges.† At the 300th round (no later measurement has been made, I believe) the delicate tests applied to the bore failed to indicate the slightest enlargement or deterioration of any kind.

The gun now at Fort Monroe is mounted upon an iron centre-pintle carriage, the top carriage of which recoils upon the rails of the lower one, and permits, by a ratchet cut in the breech of the gun, an elevation of about 28½°. The rails of the lower

* "Mr. Whitworth predicted, truly, as it has since appeared, that iron "guns, cast in solid masses, would be found incapable of resisting the great "strains to which rifled cannon are subject; it being well known that great "inequalities in the physical structure of the metal are produced during the "process of cooling, and that, beyond a certain limit, little or no increase "of strength is given to the gun by increasing its thickness of metal."—(Naval Gunnery.)

† The average charge has been 35 lbs. of *large-grained* powder, with shells of 305 to 335 lbs. weight.

carriage being inclined, the gun runs forward, of itself, from the position of recoil into battery, on rollers attached to an eccentric axis, easily brought to bear by two men with hand-spikes. Notwithstanding its great weight, it was easily manipulated by a firing party consisting of a sergeant with six men.

When fired horizontally, or nearly so, the time of loading and running into battery was, in one case, 1′ 10″; in another, 1′ 52″.

When fired at its maximum elevation of 28° 35′, the time of loading—including depressing, sponging, loading, elevating again, and running into battery—varied from 3′ 10″ to 4′.

The shell is attached to an oaken *sabot.* In loading, it is seized by nippers, the points of which enter small holes in opposite extremities of a diameter of the spherical surface. Four men, with a handspike passed through a ring (of the nippers) and standing on a platform about 4 feet below the muzzle, easily raise it. When opposite the muzzle, another man turns it on the axis of suspension, so as to introduce the sabot into the bore. It is then easily rammed home.

The weight of the shells used during the firing made in presence of the board of officers varied from 305 to 337 lbs. Captain Rodman proposes

to make them of two classes. The first for use, properly speaking, as a *shell*, may vary in weight according to the particular purposes for which it may be required. Where the greatest possible explosive effect is wanted, the shell could be of the minimum thickness admissible (to endure the shock of the charge), which, if supposed to be 2½ inches, would make a shell of about 305 lbs. weight, containing from 16 to 18 lbs. of powder. For battering, the shell would have a wall of 5 inches thickness and weight of about 410 lbs. The *windage* is 1-10th inch, and a *solid* shot would weigh 425 lbs. It is not deemed practicable to cast a satisfactory solid shot of this diameter (for reasons already mentioned connected with solid castings of large masses), and it is believed a shell of this thickness would present the maximum resistance to crushing, while the loss of weight by its 5-inch cavity is but trifling.

The most important results of the practice may be briefly stated as follows:—In firing for *accuracy* with the minimum charges mentioned, at a target 2,000 yards distant, with 6° elevation, the shot struck the ground (about 8 feet below the level of the gun) at (5 trials) 2,017, 1,937, 1,902, 1,892, 1,873 yards. The lateral deviations were, 1, 3, ⅔, 5 yards to right and 5 yards to left, showing, at

this range of $1\frac{1}{5}$ miles, a very great accuracy as regards horizontal deviations, to test which the firings were made. The vertical deviations were probably due to varying initial velocities, or perhaps to some difference in the weight of the shells fired. Had the shot been intercepted at the target by a vertical plane, they would have been found included in a vertical extent of about 16 yards—not much over the height of a three-decker.

The *time of flight* in these firings varied from $6\frac{1}{2}$ to 7 seconds, giving an average velocity of about 900 feet per second.

By experiments made for determining the *initial velocity*, the average was 1,328 feet per second with 40 lbs. of *large*-grained powder, and 1,282 feet per second with 50 lbs. of perforated cake powder.

The *ranges* with maximum elevation of 28° 35′, —shells of 334 lbs. and 50 lbs. of Rodman's perforated cake powder,—were as follows, 5,298, 4,950, 5,375 yards.

With 40 lbs. large-grain powder, they were 5,435, 5,062, 5,730 yards, and the time of flight about 27 seconds.

With 10° elevation, and 40 lbs. large-grain powder, they were 2,700, 2,900, 2,754, 2,760 yards.

These ranges do not exhibit any decided ad-

vantage of those obtained from the 10-inch gun up to 10° elevation. Beyond that elevation the gain is considerable, and may be estimated at about 600 yards for the elevation of 28° 35′. With 39° elevation, and a charge of 40 lbs. large-grained powder, it is probable a range considerably beyond 4 miles might be attained. Indeed, the conviction appeared to be general among the officers who witnessed the firings, that the gun could, *if necessary*, bear much heavier charges, though, for all ordinary uses, it is doubtless best to keep them down to somewhat less than the above.

Such charges produce far less strain on the gun than would otherwise obtain, owing to the nature of the powder used, and described above as "large-" grained," and as "Rodman's perforated cake pow-" der." The former differs from common powder only in the size of the grains, which are 6-10th inch cube, and the degree of pressure to which it is subjected in the manufacture. The latter is prepared in solid compressed cakes (subjected to a pressure in the making equal to what they will be subjected to in the gun) and perforated with holes to permit access to the flame. They are, I believe, improvements and inventions of Captain Rodman, and intended, by retarding the burning, to reduce the excessive strain to which large guns

are subject with fine-grained powders, which are inflamed almost instantaneously, and before the heavy projectile is started from its seat. This result is shown by the "pressure gauge" attached to the gun, or introduced into its chamber. The comparative initial pressures of the "perforated cake," "large-grained," and common cannon powder, are estimated to have *about* the ratios of $\frac{1}{7}$, $\frac{1}{3}$, and unity. This is a result of very great importance in its bearing upon the practicability of using cast-iron guns of extraordinary calibres.

But the question will doubtless suggest itself to many readers, "of what use are such extraordinary "calibres?" "Are not rifled guns destined to su- "percede *all* smooth-bore guns; and do not the "highest authorities 'express the conviction that "'such immense pieces of ordnance are quite in- "'applicable either for sea or land service?'" *

In reference to rifle guns, it is doubtless true that they are destined to play an important part hereafter; that they possess qualities of range and accuracy which must make them, *where these qualities are of controlling importance*, supercede the smooth-bore guns. Range and accuracy are, however, of little value, unless the projectile possesses the necessary destructive qualities. Rifle-guns do

* Vide Sir H. Douglas' "Naval Gunnery," page 174.

not prove to be the *most* effective for destroying masonry walls,* nor do they possess any decided superiority over the solid-shot gun of but 8-inch calibre, when used against iron-plated vessels.† Mr. Whitworth, indeed, forces one of his 68-pound bolts (of but 3 inches diameter) through the $4\frac{1}{2}$ inch thick plate of an iron-clad floating battery; but this can only be done *at very short range*, say 100 yards,—and a clean round hole of but three inches diameter in a vessel's side is not a dangerous affair. Sir Wm. Armstrong's gun is mainly intended for shells, though it may be used as a solid-shot gun. He admits, however, that the "expe-" diency of using it as a solid-shot gun is doubtful," and that "iron-plated vessels are practically secure " against any shot he can send against them." For short ranges the rifle gun possesses no very decided superiority over smooth bores, while the expense and trouble of using them is much greater. They will, therefore, be mainly used in our sea-coast batteries as a *shell gun*, and for long ranges upon distant or approaching vessels. All our most important works should include a certain number of

* Ibid., page 235.

† "Experiments upon the Alfred showed but slight advantage in Whit-" worth's weapon or projectile, over the solid 68-pounder, as an annihilator " of iron plates."—(Blackwood's Magazine, May and Nov., 1860.)

these guns in their armaments, and it is pretty certain that we need not be behind any nation in their construction.

To return to the question as to the use of such extraordinary calibres. It might with almost equal propriety be asked, "What is the use of *any* "*guns?*" Confining the answer to their uses in sea-coast batteries, it would doubtless be, "To destroy or "disable the enemy's ship or floating battery which "should attempt to engage or to pass it." This being the real and only object for which the battery is erected and the gun placed on it, there should be no other limit to the calibre than the *perfect attainment* of this object. For ships or floating structures, the calibre is limited by considerations of weight, &c., which need not be considered in the shore battery.

"Unwieldiness" is doubtless an objection; but the reverse quality is not *everything*, and it is better to be a half hour (if it were necessary) firing *one* shot that does its business, than to expend the same time in firing *ten* which do no harm.

The number of 24 and 32 pound shot which timber ships have received in their side in naval actions without being disabled would be incredible if not authenticated, yet vast numbers of such guns are *at this day* mounted in European sea-coast bat-

teries. In face of all experience, such guns are expected to accomplish their object of preventing the passage of, or driving off, an enemy's fleet,—and when they *do not*, the cry is raised, that forts are of no avail against fleets. In all the actions which we read of in which ships have obtained apparent advantages over batteries, or have been able barely to maintain an equal contest, they have had no heavier calibres than these to contend with. Such shot either fail to penetrate entirely the vessel's side, or, at best, make a hole which almost closes, of itself, by the elasticity of the wooden fibres. Possessing little *mass*, immense *velocity* is necessary,—a circumstance unfavorable to *smashing* effect even if their magnitude was sufficient. A leaden bullet fired from a pistol will penetrate a pane of glass by a clean round hole; the same thrown by the hand will *smash* it to fragments. To *damage* a vessel seriously it is not the hole-puncturing property which we need, it is *the smashing* effect—*the staving* in of planking and timbers; or, if a hole alone is made, that it shall be so large as to defy plugging. Of course, it is the larger projectile *only* that can make the large hole; and all experience (as well as theory) tells us that, for *smashing* effects, large *masses* with moderate *velocities* are the most

efficient.* The remarkable effects produced by the dilapidated and poorly-manned Turkish batteries on the Dardanelles, upon Admiral Duckforth's fleet, in 1807 (fully related in my pamphlet on the "Dangers and Defences of New York"), are sufficient to prove that large-calibred guns are not only not unmanageable, but the *only* kind of gun proper for sea-coast defence, for no other will produce, by a *single hit*, such disastrous effects; and a multitude of nearly harmless hits are no equivalent, as experience of naval actions has so fully shown, for such vital blows. Against *wooden* ships the shell is doubtless the most effective missile. We would increase its range to the outside limit of actual solid-shot range, and we would make it of such capacity as to disable a vessel by a single explosion. For *this*, too, we must have large calibres.

This is by no means a novel idea with American engineers. From the very beginning of their labors on sea-coast defences, they have demanded *large guns* for their batteries. This demand has been met by our Ordnance Department as rapidly as the means have been perfected of *manufacturing* large-calibred ordnance. 24-pounder and 32-pounder guns have given way *entirely* to larger guns. The

* Naval Gunnery, page 241.

42-pounder (retained of late years only as a *hot-shot* gun) will soon be discarded, when the armament of our important sea-coast batteries will consist *exclusively* (until we add something still *larger*) of 8 and 10 inch Columbiads, capable of use as shell or shot guns, as occasion requires,—*hot shot* being fired from the 8-inch gun.

We believe these guns to be most formidable, and that no fleet would attempt to pass an array of batteries so armed without so imperious a motive as to justify the most severe losses; and we believe (since the degree of invulnerability that can be given to a floating structure is necessarily limited) that no floating battery that is, or *will be* built, will successfully contend with our batteries (whether they be of masonry or earth). But we do not believe that we have yet attained the extreme limit of calibre which sea-coast batteries require, or, rather, which may be *advantageously used* in them. In the words of the Board of Officers who witnessed the firings of the 15-inch gun at Fort Monroe, and who *unanimously* recommended (after certain further test firings) its adoption, "There may be cases in which it is of the utmost "importance that a *single missile* shall be sufficient "—if not to destroy—to entirely disable" the vessel at which it is directed. Such an effect can only

be expected from a gun of "extraordinary" calibre. The great facility with which the 15-inch gun is *wielded*, proves that its magnitude is not inconsistent with efficient service.

The introduction of a new engine *specially adapted to the attack of fortifications*—I mean the iron-clad floating battery—and the probability that ships-of-war will soon be mostly clad in plates of iron, invulnerable to ordinary solid shot, call for some counteracting agent in the shore battery; and that agent will most likely be found in the use of projectiles of extraordinary calibre. Recent writers on these subjects exult in the expectation that iron-clad ships of war will soon supersede the wooden, and that they will be so practically invulnerable that they "can engage at breaching dis-
"tance, with effect, *any* land battery." However this may be, it is perfectly certain that *hereafter* it is not with ordinary fleets of wooden ships that sea-coast batteries will be called upon to contend. Such fleets may indeed attempt, for ulterior objects, to *pass* rapidly by such batteries, but if the object is their reduction, as was the case at Algiers, at Vera Cruz, at St. Jean d'Acre, at Sevastopol (naval attack of Oct. 17, 1854), at Cronstadt (threatened but not attempted), the attack will be made, not with "Agamemnons," "Arethusas," and "Albions"

—wooden coffins filled with sailors, to be burnt up or blown up by modern incendiary and explosive missiles, as was the Turkish fleet at Sinope, "in fifteen "minutes"*—but with vessels especially *designed for the purpose*, viz.: the bomb-vessel and the iron-clad floating battery,† and, *probably*, iron-clad ships of war.

* At Sinope two Turkish frigates were blown up *in fifteen minutes* by the shell guns of the Russian fleet. In the contests which the allied fleets had with Russian fortifications, the modern armament of shell guns of large calibres does not appear to have existed; and hot shot, if used at all, were used very sparingly. Hence, those contests afford no indication of what the result would be of contests of wooden vessels against batteries armed with large-calibred shell guns, &c.

† In my pamphlet on the "Dangers and Defences of New York," I did not hesitate to call the naval attack on Sevastopol (October 17, 1854) "the "last attempt to array ships of the line and ordinary vessels of war against "fortifications." The writer of "Iron-clad Ships of War," in Blackwood's Magazine (November and December, 1860), uses identical language:—

"On the 17th October, 1854, the final experiment of wooden ships against "granite and earthern walls was made,—never, we believe, again to be re-"peated until iron-clad ships range up in line of battle."

He also gives a summary of the *results* of that attack and of the taking of Bomarsund, which I quote, for its confirmation of statements of mine elsewhere made, and for reference hereafter:—

"The allied fleet was repulsed. The Agamemnon, the Albion, Sans-"pareil, and other ships, did all that skill, gallantry, and daring could "accomplish to silence that Fort Constantine. They did not succeed; neither "will the Russian official accounts acknowledge that any damage was in-"flicted, other than injury to the guns and parapet of the crown of that "fortress, where the cannon and men were exposed. To Bomarsund we "need not allude, further than that it defied a huge allied fleet, but went "down, like a fortress built of a pack of cards, when a small division of

It is well known that in the Russian war iron-clad floating batteries (the sides coated with wrought-iron plates, 4 or 4½ inches thick) were built by the allies, for their intended operations against the Russian fortifications in the Baltic and Black Seas. The only trial that was had of them was at Kinburn, where three French floating batteries, in conjunction with the enormous allied fleet, engaged (at about 800 yards distance) in the attack on that feeble place.* The result was not unsatisfactory. One of them was struck sixty-three times, with no material damage. In short, these batteries may be considered to have shown themselves *shot-proof at that distance* (800 yards), and *against* 32-*pounder shot.* Not a very decisive test, to be sure; for, though so feeble and dilapidated a work as Kinburn may be engaged with effect at 800 yards, a well-arranged *masonry* work, or earthen battery, must be engaged at 400, or even 200, yards to produce any effect, whether the intention be to batter, or to throw grape and canister at the enemy's gunners; and, instead of 32-pounder shot, they must expect to be hammered at

"troops was directed upon it, and when our ship-guns, instead of being "fought behind parapets of wood, were placed on shore, and the crews "properly protected."

* An account of this affair is given in the pamphlet already alluded to, entitled "Dangers and Defences," &c.

by solid shot of not less than 8 inches diameter, or 68 pounds weight.

Various experiments have been made in England to test the resistance of these vessels—or of targets constructed in like manner—to the Armstrong and Whitworth projectiles, and to 68-pounder shot. Sir H. Douglas records many of the results, in the recent edition of his Naval Gunnery, and emits the opinion that "no perfectly shot-proof ships, capable of resisting a protracted cannonade of 68-pounder solid-shot guns, and the new rifled guns, has yet been produced;" and that "iron, whether cast or wrought, is the worst material, excepting steel, that can be used for strengthening either sea or *land* defences;" and that "iron vessels are and will be found unfit for all purposes of war."

Per contra: able and professional writers in the London Quarterly Review* and Blackwood's Magazine hold the opposite opinion, and announce their belief that "wooden walls" *must* give way to something which will exclude the fearful missiles which modern science has invented. These opinions are shared by many of the ablest officers of the British navy.

* The writer says of Sir Howard's opinions, "It is difficult to see by what process of reasoning he arrives at this result." And Blackwood says, "On all the many professional points involved in iron-clad ships, we cannot think him a safe or impartial guide."

It would be tedious to enter into the details of the experiments made. In general terms it may be stated that, *with proper support behind*, 4½-inch iron plates are practically proof against shells, hot shot, and cast-iron shot (nothing over 8 inches has been tried, I believe); that they have been penetrated by *wrought-iron* 8-inch shot at short ranges (say 200 yards—only, I believe, by successive hitting on or near the same spot); and that Mr. Whitworth has forced one of his flat-headed wrought-iron projectiles through 4-inch plates, at 200 yards distance, on the side of the floating battery "Trusty," and at 400 yards on the side of the frigate "Alfred." The conclusion arrived at by the advocates of this method of construction is, that the ship of war or floating battery, *properly built*, may be considered practically safe against the projectiles I have mentioned, beyond 200 yards. Assuredly, in this day, when many naval officers declare* that naval en-

* Sir Howard Douglas does not appear to be of this opinion. He thinks that naval actions will be commenced and carried on at great distances, and will "be conducted with the utmost circumspection, tactical skill, and prac-"tical science." As the "final struggle and close quarters" must come at last, however (at least when fleets are engaged),—and, as he admits, it is "not always in the power of the commander of a ship, however desirous he "may be of avoiding close action, to be able to accomplish that purpose," —it is not very apparent how these predicted destructive effects will be escaped. Certain it is that the successful introduction of iron-clad vessels by one nation will *compel* their adoption by others who would not be driven from the ocean.

gagements between wooden vessels are like to be Kilkenny cat-fights,—when *which shall go to the bottom last* (if time is worth *counting* when the process, for both parties, is so brief) is the main question,—it is an immense step in the direction to which things must inevitably tend to have vessels which can claim this degree (no small one) of invulnerability.

Acting upon such views, the French Emperor has built an iron-clad ship of war—"Le Gloire"—carrying 38 rifled 50-pounders, and is now building, according to Blackwood, nine more, so as to have, by next Spring, 300 rifled guns afloat in such vessels. England is following suit, and in the "Warrior," a vessel 420 *feet long*, and of over 6,000 tons, is building a rival to "Le Gloire."

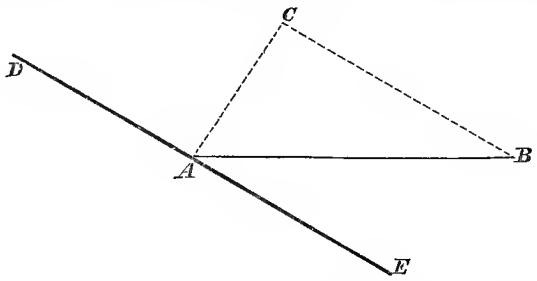
A new principle has, however, been introduced in England, which is calculated to give a much greater degree of invulnerability—that of inclining the iron-clad sides inwardly (to an angle with the horizontal of 35° or 40°)—by which arrangement shot will glance off with little injury to the side.*

* If a projectile strikes a plane surface *perpendicularly*, its whole *living force* (*rotary* velocity not being considered, as it is not very great in balls from smooth-bore guns) is available *at the point of impact*, either in penetrating or breaking through the surface.

If it impinges obliquely its velocity, $\overline{A\,B}$, may be considered as decom-

In addition to this, it is proposed to suppress the *port-holes* (certainly a very desirable step towards obtaining a satisfactory degree of invulnerability), and to place the guns in rotating iron *cupolas* (ac-

posed into two components, $\overline{A\,C}$ and $\overline{B\,C}$, the first of which *only* is available in rupturing the plane. If the angle, B A C, were 45° (*about* the angle of



incidence for the proposed inclined ribs of ships of war), the living force (or power of doing the *work* of smashing or penetrating) due to the component, $\overline{A\,C}$, is just *half* of that due to the entire velocity of the projectile, $\overline{A\,B}$. Thus, by this simple arrangement, the projectile is at once disarmed of half its destructive powers. But this is not all: the projectile will not *concentrate* all the effect due to the component, $\overline{A\,C}$, at the point A, as it would if $\overline{A\,C}$ were the *only* velocity with which it arrived. By the component, $\overline{B\,C}$, it will be carried along towards D, simultaneously with the action of A C, upon the plane. For want of concentration upon a *single point*, the *penetrating* power of the component, $\overline{A\,C}$, may be considered as (within certain limits) *wholly lost;* the entire *living force* due it is, nevertheless, *wholly* expended upon the bulwark, E D (provided it does not escape at the point D, before the reflection is complete); but it is likely that the *smashing* power (i. e., of *breaking down* the bulwark) is much diminished (owing to its distribution over considerable space). In short, with an angle of incidence of 45° the power of penetration of the ball would be *wholly* lost; that of smashing the bulwark reduced to considerable below *one half*. If, therefore, we throw at these inclined sides a projectile of such magnitude that its *living*

cording to an invention of Captain Cowper Coles, R. N.), from which, by a rotary of 180°, they fire *over* the bulwarks on either broadside,—the gunners being perfectly sheltered under these shot-proof covers.

Grave objections to such an arrangement of guns, particularly in an unstable and rolling structure, readily suggest themselves. It would not do, however, for a landsman—probably not for a seaman—to pass judgment upon it before thorough trial has been made. It is probably worth that trial, and, if not found successful, may lead to something of the kind which *will* be.

A vessel arranged according to these ideas,* having the length and beam of a three-decker, would carry but 14 guns (available on either broadside). But it is contended, with much justice, I think, that such a vessel, almost invulnerable to anything carried afloat, to such sea-coast artillery as European works are armed with, is a far more formidable

force is considsrably more than double—say four times—that which experience shows sufficient to break down a vertical bulwark, we may expect to accomplish the object. At any rate, we can do it without going beyond the limits of *practical magnitude* in projectiles.

Experiments at Metz, in 1834, showed that masonry walls could be *breached* at an angle of 25° or 30° with (I suppose) ordinary breaching artillery, viz.: 18 or 24 pounders.

* For a full description of the proposed vessel, and a discussion of the subject generally, see the interesting papers in November and December numbers of *Blackwood's Magazine.*

vessel than the vulnerable, fragile, and combustible 100-gun three-decker, incapable of approaching a fortification or of engaging an enemy, except at *long range*, without the strong probability of being blown up, or sent at once to the bottom, and in imminent danger even from the accumulation of powder and shells for so many guns in so limited a space; while her reduced crew (250 against 1,000) would soon compensate for her enhanced cost, and relieve the question of finding *men* for ships of war of much of its difficulty.

In devising our sea-coast armament, all these facts, all the *established* improvements in military and naval art, and all clearly-seen *tendencies towards progress and change*, must be considered. The rifled gun, from its great accuracy and penetrating power, and more especially for its power of throwing a loaded shell with an accuracy and range beyond what have heretofore been considered to belong to solid-shot guns, is a very important gun to sea-coast batteries. Its most important use, however, will be as an incendiary and explosive agent against wooden vessels at long ranges. Its principle has not yet been successfully applied to large calibres,* and it is not likely it will be, not only because of their

* The largest Armstrong gun is the 80-pounder, of which the calibre is seven inches. It has been fired with a 100-pound projectile. Whitworth's 68-pound *bolt* is fired from a gun of but three inches in calibre.

much greater expense and difficulty of construction, but because the peculiar advantages of the rifled over the smooth-bore gun diminish with the calibre.* They are not (as I have remarked before) a formidable projectile against iron-clad ships. The 3-inch hole which Mr. Whitworth makes by firing a *wrought-iron bolt* at 100 or 200 yards is not a serious injury, and can only be made at distances less than we should be permitted to count upon. It is not to *bore a hole*† through these iron plates, but to *smash the sides* of the vessel that carries them, that we have to do. They are practically proof against Armstrong's guns. 68-pdr. wrought-iron shot from an 8-inch columbiad would, by dint of hammering, at 200 or 300 yards, succeed in breaking out pieces of *vertical-sided* vessels. This effect is quite inadequate, though, even against such vessels. Against the *inclined-sided* vessel even our solid cast-iron 10-inch shot would probably glance off without doing such serious damage as we desire.

* Vide Thomas' work on "Rifled Ordnance."

† It has been suggested that the iron-clad vessel may be penetrated by the Whitworth bolt *below water*, and sunk. Of this contingency the *Blackwood* writer discourses as follows:—"'A chance shot,' as the American one-"gun privateer observed to the captain of a 50-gun frigate, 'may knock the "'devil's horns off;' and a chance Whitworth may have passed through "thirty feet of water and penetrated a wooden bottom; but to make direct "practice, his gun must be within twenty feet of his opponent."

We have nothing, therefore, which will thoroughly and completely accomplish the object for which our battery is built. We have gone to enormous expense in works to protect our cities and harbors, and find that the instrument, of which the work is but the emplacement, is inadequate. We have got our "mon-" ster," and find, if not "toothless," at least its teeth are only fit to masticate flesh, and they are given *nuts to crack*. It is sheer nonsense to talk about "unwieldiness" in such a case. The gun that will do the business required of it *must* be wielded, whether it is found to be a 15 or a 20 inch, or even a *thirty* inch, gun.*

When these iron-clad ships come to "engage, at

* The writer (M. Delamarre) of a series of articles in one of the Paris journals, entitled "Les ports maritimes et l'artillerie moderne," of which the principal object is to point out the measures rendered necessary, by improvements in modern artillery, for the security of the sea-ports of France, uses the following language in speaking of Brest:—

"L'entrée du goulet de Brest a été *jusqu' á present* fortement défendue "par 270 bouches a feu, qui eussent assurément coulé un capitaine ennemmi "assez audacieux pour tenter de forcer le passage. Elle peut être encore "mieux défendue au moyen de canons d'un *énorme calibre*, et d'autres ap-"pareils qui *ecraseraient infailliblement* les plus solides vaisseaux blindés, "frappés à bout portant." ("The entrance to the port of Brest has been "*hitherto* defended by 270 guns, which would assuredly have sunk the ene-"my bold enough to attempt to force the passage. It can be still better "defended by means of cannon of *enormous calibre*, and other contrivances, "which would *infallibly crush* the strongest iron-clad vessels at point-blank "range.") (The italics are mine.)

"breaching distance, our earth or stone forts," and to have their "laugh"* at them, we do not try to *punch* holes in them; we wish to stave in the whole

* The writer of the articles already referred to in *Blackwood's Magazine* thinks that "before another twelvemonth every sensible person in this "country will see the folly of erecting forts of stone or earth for iron-clad "vessels to laugh at" Not so fast, my dear sir. *Festina lente* is yet a good maxim, as well in forming conclusions as in substituting new methods and constructions for old. Do the best you can to make your floating structure shot-proof, and they cannot endure the protracted battering which they *must* endure if they would "engage at breaching distance" a *properly-built* and *properly-armed* stone or earthen fort. The subject will be referred to in what I propose to say about casemate embrasures. Admitting, for the sake of argument, however, that there is any reason for believing that well-built masonry batteries may be breached by guns in iron-clad vessels, it is easy to turn the balance the other way by resorting to the same means for procuring invulnerability that the floating battery does, viz., *iron plates*. In *this kind of contest* (for invulnerability) all the advantage is on the side of the shore battery. "The idea that a *floating structure* can be made shot-"proof while the walls of a fort cannot, is so transparently absurd as "scarcely to require refutation."—(Dangers and Defences.) And with all due deference to Sir Howard Douglas, *masonry* will form the *mass—iron*, the *external protection*—of such a battery. The stone fort, *therefore* (indispensably necessary in many cases for want of sites suitable for anything else), will require but the *addition* of the iron sheathing to give it the required degree of invulnerability. To make it *wholly of iron* would be a pure waste of money. General Totten, after elaborate experiments, has used the following language:—"Were it not for the vastly greater cost, the "whole scarp might be faced with iron—indeed, might be made of iron "only; but, until there shall be much stronger reasons than now exist, or "are now anticipated, for believing that well-constructed masonry batteries "may be breached by naval broadsides, the cheaper construction may be "safely followed, especially as, should such a necessity ever arise, they may "be externally plated with iron."

side. For this purpose masses of *large diameter* moving with *moderate velocity* are indispensable. The 15-inch shell would probably be effectual against the inclined-sided battery, and would be likely to convert Captain Cole's cupolas into *shooting-caps* indeed. Penetrating and exploding in an iron-clad or wooden vessel, a single one would probably suffice. The inclined side of these newly-proposed ships would not, perhaps, be easily *penetrated* (though the side would, doubtless, be *stove*), even by such a shell. But it must be recollected that about one-half of such a ship is not invulnerable—the citadel, or protected portion, occupying only the midships—and the effect of such an explosion in the bow or stern would tell fearfully upon the ship, and upon such of the crew as were not in the "citadel."

Fifteen inches is the calibre of the gun made as an experiment to test the practicability of casting guns of extraordinary calibre, and their efficiency. The result has convinced our Ordnance officers that it is not an extreme limit. A 20-inch gun can probably be made, and not only *made*, but *used* with facility and efficiency. Enormous and expensive as they are, such guns may have their "mis-" sion," and a few of them in our important sea-coast batteries will probably be hereafter deemed an essential part of their armament.

CASEMATE EMBRASURES.

Casemate Embrasures.

Guns intended for sea-coast defence may be arranged to fire over an earthen parapet, in which case they are uncovered and without protection from ricochet or vertical fire; or they may be placed in "casemates,"—*i. e.*, under bomb-proof vaults, behind the masonry wall of a fortification. Each mode has its own particular advantages and disadvantages, to which I may refer hereafter: at present it is enough to say that the choice is not always optional, and that every nation that has defended its coasts at all has found it necessary to make use of casemated batteries.

The placing of a gun "in casemate" involves the necessity of some kind of an opening in the masonry wall in front of it, that the gun may fire through, which opening is called an "embrasure." This opening must not only permit the gun to fire through, but it must permit a horizontal latitude of direction as great as possible. At the same time

that this horizontal latitude of fire, or "traverse" of the gun, should be a maximum, the greater it is the greater must be the cavity cut out of the wall to allow it; and it is evident that the larger the cavity cut out, the more it weakens the wall, and the more of the enemy's missiles it will receive.

"The great importance of keeping the area of "the outside openings of casemate embrasures at a "minimum will clearly appear from our experiments. "*First*, the number of the enemy's missiles passing "through the opening will, of course, increase with "the enlargement of that area; and, *secondly*, what-"ever may be the peculiar form of any embrasure, "there must be a margin, larger as the opening is "larger, where the walls, being materially weaker "than elsewhere, will suffer the more from battering "guns."*

The magnitude of the hole cut out of the wall, as well as the area of the external opening, will depend not only upon the degree of "traverse" given to the gun, combined with the thickness of the wall, but upon the position of the centre of motion of the carriage.

European engineers have in general acted as if they regarded the magnitude of the opening of little

* *Vide* General Totten's Report on "Casemate Embrasures."

consequence. Taking the center of motion within the inner face of the wall, they have necessarily given the embrasure a "flare," or outward spread, through the whole thickness. As a necessary consequence, the exterior opening is immense, even while the traverse of the gun is limited to but 30°.

American engineers, impressed with the importance of the matter, have never—even in the earliest of their works—constructed embrasures of the enormous size now seen in European works of recent date. The form of embrasure, however, which was adopted, and is now found in nearly all our constructions up to 1852, was designed by General Jos. G. Totten, who describes it, and the manner in which he was led to the design, as follows:—

"In 1815, the author of this report* was called "on to prepare a project for the defence of an im- "portant channel; and, having been convinced, "while employed as an assistant in the construction "of two of the batteries just mentioned, that the "principles and the details by which the embrasures "and the dependent casemates had thus far been "regulated were erroneous and defective, set about "a careful study of the conditions to be fulfilled in "providing for the heavy guns of that period, "mounted on a casemate carriage, that had already

* On "Casemate Embrasures."

" been proved and adopted. The result was an " embrasure having an exterior opening of 4 feet " wide by 2′ 6″ high at the " outside line of the cheeks, " and 3 feet high at the key " of the covering arch,—the " throat being 1′ 10″ wide. " This provided for all the " depression and elevation

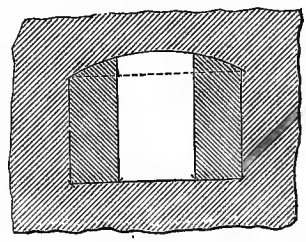


Fig. 1.

" of the gun that the carriage permitted, and also " for a horizontal scope of full 60 degrees. Covered " with a lintel, instead of an arch, the height of the " exterior opening might be a little less than 3 " feet."

"The plan of this embrasure shows that the " interior opening is 5′ 6″ wide, and that the plane " of the throat is within 2 feet of the outside of the " wall."

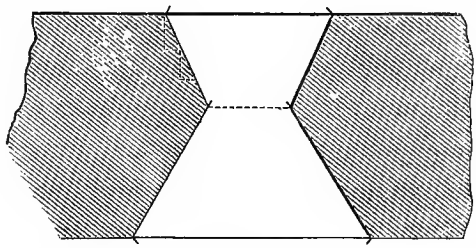


Fig. 2.

This form gives the maximum strength (with a given thickness of wall) that it is possible to give

a *pure masonry* embrasure. The gradual increase in the calibre of guns—the necessity of resisting the shock of heavier projectiles than those formerly in use—suggested to General Totten the necessity of an increased thickness of wall, and an arrangement combining other materials than masonry, by which greater strength could be combined with the minimum opening, and prompted the course of experiments which are described in the Report to the Secretary of War on "Casemate Embrasures."

To use his own language:—

"The principal objects of the experiments were—

"1st. To ascertain the effects of firing with solid "balls, with shells, and with grape and canister, "from heavy ordnance at short distances, upon "various materials used in the construction of case-"mate embrasures."

"2d. To determine whether these embrasures "might have a form that would shut out most of "these missiles, and resist, for a time, the heaviest, "without lessening the sector of fire, horizontal and "vertical, of the casemate-gun."

"3d. To determine the degree to which, without "injury from the blast of the gun, or lessening its "scope of fire, the throat of the embrasure and also "the exterior opening might be lessened.

"4th. To determine whether all smaller missiles

" might not be prevented from passing through the " throat into the battery, and whether the smoke of " the blast of the gun might not also be excluded " by simple and easily-managed shutters."

The results of these experiments were considered by General Totten " of great importance to the " defensive system of the country." It is not likely that he believed they would be considered important to the defensive systems of other countries, for European engineers have not been in the habit of looking in this direction for information, or for precedents. That the experiments should have been noticed by Sir Howard Douglas, in his " Naval " Gunnery," was probably not expected; but, if noticed, it certainly was expected that it would be in a manner indicating that that distinguished writer and high authority had attentively read and perfectly understood the work he considered important enough to notice. That he has done neither is not very difficult to prove.

That he has not *attentively read* the report of General Totten on " Casemate Embrasures," which he reviews, there are numerous evidences. In stating the " objects " for which the experiments were made (just quoted by me) he extracts verbatim from the text until he comes to the 4th, which he writes in this way:—" To determine whether all smaller mis-

" siles might not be prevented from passing through " the throat into the battery *by shutters, consisting* " *of two leaves of boiler-iron, ½ inch thick, hinged* " *to vertical throat-irons, &c.*" (the words in italics being Sir Howard's own reading of the matter). General Totten's own words are, " by simple and " easily-managed shutters,"—the thickness and manner of construction being matters to be determined. The conclusion arrived at is afterwards distinctly stated by him. "A thickness of *two* inches is ample " for shutters designed to stop the largest grape-shot." And this two inches thickness is to be of *solid* wrought iron.

After quoting some of the results of the firings, Sir H. Douglas says, " It must have been from " doubts such as these, of the efficiency of the expe- " dient and the cost of executing General Totten's " proposition, that the War Department declined to " carry it into effect, in the following terms;" and the " following terms " are the words, *verbatim et literatim*, of two paragraphs of my pamphlet on the Dangers and Defences of New York (page 39), the first being a *quotation* from the very work of General Totten which Sir Howard is reviewing; the second, *a comment of my own;* the purport of the two being simply that *the whole scarp* of a masonry battery, as well as the embrasure, may be rendered invulnerable

by iron plates. The strange and utterly inconceivable sense given to these paragraphs by Sir Howard is puzzling enough, standing by itself. But if he had attentively read the work before him (a Report addressed to the Secretary of War) he would have found the following paragraphs, in which the sanction of the War Department is expressly affirmed, and which would have saved him from so absurd a misapplication of the language of another:—

"The embrasure applied, since these experiments, "to our casemated batteries, and which may be "called the embrasure of 1855, devised in accord- "ance with these deductions, and of which a *model* "*received your approval*, is believed to satisfy com- "pletely all important conditions." (Italics my own.)

"The greatly augmented strength and efficiency "thus imparted to our system of national defence "will be due to the enlightened and liberal forecast "which prompted you, as Secretary of War, to "sanction and sustain the course of experiments of "which this report is the record."

Sir H. Douglas remarks, "Well do the distin- "guished military engineers of the United States "see the absolute necessity of endeavoring to remedy "the serious defects of their masonry defences, which "their older brethren of 1808 introduced fifty-two

" years ago, by strengthening the throats of the " embrasures with enormous slabs of iron."

There is no embrasure in existence in the United States which dates back to 1808; very few indeed farther than 1815. The embrasures which have been made since that date " in all our casemated " batteries " are described, in language already quoted by me, as the *design of General Totten himself*, who states that they " have, since 1815, been " constructed, in all our casemated batteries, accord- " ing to the preceding description;"* and the reasons why an " increase of strength " had become necessary are stated by him, in the Report Sir Howard was reviewing, as follows:—

" This being the state of things with these em- " brasures of 1815, an increase in their strength had, " within a brief period, become expedient, not to " say necessary, by the augmented calibres in ships' " armaments."

The particular " form " had nothing to do with these reasons (for the wrought iron throat-plate is resorted to in the new embrasures because a *new* form, better calculated to exclude missiles, is introduced); but it was (as explained in par. 219), whether the " thickness of scarp," which had been " found sufficient to resist 24 and 32 pounder shot,

* *Vide* " Casemate Embrasures," ¶ 246, p. 166.

" was *now* sufficient, with the growing calibres of " naval armaments." More than 500 embrasures have, since 1855, been constructed in the United States according to the new model.

The foregoing remarks will illustrate the " care- " ful perusal " of the work noticed by Sir Howard. That he has not *perfectly understood* the work upon which he so freely passes judgment, is perfectly evident from the whole tenor of his remarks. These experiments, which were made at two different periods, on ten different embrasures,—some of one material, some of another; some with iron shutters or iron throat-plates, some without (the particular arrangement differing in every case),—were made to determine the best material, the best form, and the exact arrangement, degree of strength, and manner of construction of the wrought iron throat-plates and shutters intended to be used. Sir Howard treats them as if they were experiments made upon the new American embrasure, instead of the *trial experiments*, by aid of which it was devised. Under no other point of view could he quote these results as he does, *as results applying* to our system, or use language like the following:—

" To strengthen the throats, cheeks, and outer " edges of the casemate embrasure, masses of " wrought iron, 8 inches thick, composed of sixteen

" plates, each ½ in. thick, firmly welded together, " backed by *slabs of cast iron*, forming a frame on " the sides, sole, and top of the throat, are firmly " bonded into the masonry,—the cheeks notched in " planes parallel to the face of the wall, or covered " with wrought iron plates." (Italics my own.)

General Totten says :—

" Our experiments show that wrought iron is " the best material for insertion, as above mentioned, " and that a thickness of 8 inches of wrought iron, " *solidly backed with masonry*, will resist an 8-inch " solid ball, fired with 10¼ pounds of powder, from " a distance of 200 yards." (Italics my own.)

And, with reference to *cast iron*, he says :—

" The brittleness of cast iron unfits it for use as " a means of directly resisting the shock of cannon- " balls. This has long been well known. It was " considered, however, worth while to try whether " its cohesive strength might not be profited of by " diffusing the shock of a ball over a considerable " surface of this material through the intermedium " of a thick plate of wrought iron. The compound " plate of wrought iron interposed in the trials was " made up of eight half-inch plates, solidly riveted " together ; and a very even and uniform bearing of " this 4-inch compound plate upon the cast iron was " secured,—as perfect, certainly, as could be effected

" in general practice; nevertheless, the cast iron " block was always broken, splintered, or badly " cracked, by a ball striking the wrought iron plate " in front of it."

That General Totten's " conclusions " as to the use of wrought iron may be fairly known, I repeat them here :—

" Some important conclusions may be drawn " from the results with wrought iron."

" *First.* It may be fairly assumed that a plate " 8 inches thick, of wrought iron of good quality, " kept in place by a backing of three feet of strong " masonry, will stop a solid ball from an 8-inch " Columbiad, fired with $10\frac{1}{4}$ lbs. of powder, from " the distance of 200 yards. The plate of iron " will be deeply indented at the point of impact, " the ball carving for itself a smooth bed, of the " shape and size nearly of one hemisphere, in which " it will be found broken into many pieces, easily " separable; and it will, besides, be somewhat bent, " generally. The masonry behind will be much " jarred, and, unless strongly bonded, be consider- " ably displaced; moreover, unless the thickness " of three feet is well tied into thicker masses " immediately adjacent on the sides, and above, " and below, the general damage will be severe."

" *Second.* This plate will be much the stronger

"for being in a single mass, and not made up "of several thinner plates. The continuity effected "by bolts and rivets of the made-up plates is "broken, even by weak assaults; so that afterward "the stronger, instead of a joint opposition, finds "only a succession of feeble resistances."

"*Third.* A thickness of two inches is ample "for shutters designed to stop the largest grape-"shot. With this thickness they will be neither "perforated nor deformed by anything less than "cannon-balls or shells. These shutters, also, for "the reasons just given, should be made of a "single thickness. The firings show the necessity "of concealing entirely, even from the smallest "iron missile, their hinges and fastenings."

"*Fourth.* A wrought iron plate of half an inch "in thickness is adequate to protect the outer mar-"gins and the offsets of embrasures from injury "by grape or canister shot."

Those who read Sir Howard's chapter on "Iron Slabs combined with Masonry" doubtless suppose (for his language leaves no room to suspect the contrary) that he is actually describing the American embrasure, and that the experiments he describes refer *to it.* General Totten has given, indeed, certain conclusions, but how he has embodied those conclusions into an embrasure he

has *not* stated. It is most evident, from the opposition I have shown between his own language and the descriptions and remarks of Sir Howard, that the latter has not the *slightest idea of what the new-modeled embrasure really is;* yet he boldly pronounces judgment, as follows:—

"A careful perusal of General Totten's work, "and an attentive examination of the results of "the experiments carried on to test the efficacy "of the expedient proposed by him, have left on "the author's mind two very deep impressions— "he might say, convictions: first, as to the inability "of masonry walls in general to resist the impacts "of solid shot of large calibre; and, secondly, as "to the defects of all masonry defences, and to the "form proposed to be given by General Totten to "*the casemate embrasures of his system in par-* "*ticular.*" (Italics my own.)

General Totten, after a long life spent in the active exercise of his profession, has probably a greater experience in designing and constructing, and a more universal acquaintance with the examples, here and abroad, of sea-coast fortifications, than any man living; and, an *engineer* by profession, with fifty years of incessant practice, his opinions as to the strength of materials and their capability of resisting the impact of projectiles necessarily

carry much weight,—enough to have justified Sir Howard in withholding his judgment upon "his system" until he knew what it was.

The *form* of the American embrasure appears to be the object of Sir Howard's particular animadversion. "In the United States embrasure," he says, "the throat is placed within two feet of the wall,* "and, *consequently*, the width of the parapet out- "wards is reduced to two fifths of the thickness of "the wall."

The propriety of the "consequently" is not very apparent. There is about the throat of every embrasure ever yet designed (not strengthened by iron) a weak portion, more easily broken than elsewhere. This is an evil not peculiar to the old American embrasure; on the contrary, it is easily shown that its form is that best adapted to strength.

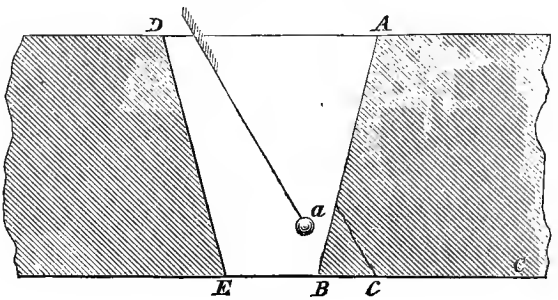


Fig. 8.

* Within two feet of the *outer face of the wall*, we will presume Sir Howard to mean.

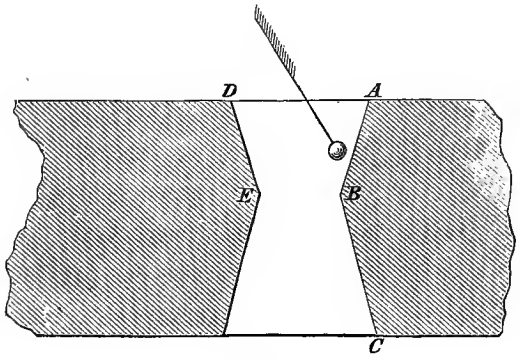


Fig. 4.

Fig. 3 represents the horizontal section of an embrasure of a common European model.

Fig. 4, that of the American embrasure, having its throat $\frac{2}{5}$ the thickness of the wall from the exterior face, both having a "flare," or allowing a traverse to the gun of 30°.

Does it require any demonstration to prove which is the weakest? The angle *A B C*, in the American embrasure, would be an *obtuse* angle of 150°; the angle *A B C* of the European model would be an *acute* one of 75°. A shot striking the flaring cheek of the second (as represented in the figure) would be likely to break off the acute solid angle *a B c*, along the line of fracture *a c*, carrying away a large mass of masonry, and very much enlarging the throat; while a shot striking the cheek A B of the other would be less likely to

break away the angle, and, in doing so, would carry away much less masonry, and, consequently, cause less enlargement of the throat. What a misuse of words—what mere random talk—it is to say that " the parapet outwards is reduced to two fifths the " total thickness of the wall !"

Not only has the old American model the superiority just described, but it has another of great importance. With the same width of throat, $E B$, the *exterior opening*, $A D$, is much greater in the European than in the American ;* and, as our experiments have shown (even with a flare double what is represented in the figure) that nearly all small missiles, and fragments of larger ones, which strike the flaring sufaces, $A B$, are reflected so as to pass through the throat, the American embrasure affords vastly greater security to the gunners—*first*, because the throat is not so easily broken in ; *second*, because the enemy's small missiles and fragments of broken shot are more effectually intercepted. So superior is this form that, instead of confining the flare of the cheeks (as I have represented in the figure, for the sake of making a just comparison with the European) to 30°, we have made it 60°, as

* Embrasures of recent European works present an opening of 50 or more square feet. That of the old model American about 12; of the new model (measured by the throat), 3.9 square feet.

represented on page 66, thereby doubling the traverse of the gun,—an effect, in most cases, equal to *doubling the number of guns.* Did, then, Sir Howard Douglas understand at all what he was writing about, when he compliments us American engineers of the *present day* with seeing the "absolute necessity of endeavoring to remedy the "serious defects of those masonry defences which "their elder brethren of 1808 introduced, fifty-two "years ago, by strengthening the throats of the "embrasures with enormous slabs of iron"?

General Totten states distinctly his objects. So far as the *strength* of the embrasure was concerned, the *form* was not involved at all. He was aware that we had the strongest form that could be made *of masonry;* but it was desirable to know whether a wall five feet thick—thick enough to resist 24, 32, or even 42 pounder shot—was still sufficient against the "larger calibres" introduced into ships' armaments. So far as *form* was the object of the experiments, it is distinctly stated that they were to "ascertain the effects of firing with solid balls, with "shells, and with grape and canister, from heavy "ordnance at short distances, upon various ma-"terials used in the construction of casemate em-"brasures," and thereby to ascertain what form would best exclude such missiles, and what materials were best adapted to that form.

His life-long study of this and kindred subjects had given him "deep convictions" as to the part which sea-coast batteries, masonry or earth, had to play—as to the peculiar tests they would be subjected to. He had no fear as to the capability of masonry walls to resist the cannonade of ships, so long as they could keep it up, against the severe retaliation to which they would themselves be exposed. Against "increased calibres," some thickening of walls might be necessary—nothing more. He knew that the *real danger* of casemated batteries (a danger to which, however, earthen batteries on low sites, with deep water near them, are tenfold more exposed) was, that ships should lay themselves close alongside and pour canister or grape into the embrasures,—their superior number of guns giving them a great advantage in this kind of contest,—unless the funnel-shaped openings (already greatly reduced from European models) could be modified so as to further reduce it to the minimum required for the muzzle of the gun.

The result of these experiments was, that the form known to be the best for strength, if executed in masonry, was abandoned; that, instead of *flaring* the faces of the masonry outwards from the throat, the flaring parts were removed, and surfaces parallel

and perpendicular to the surface of the scarp-wall substituted.

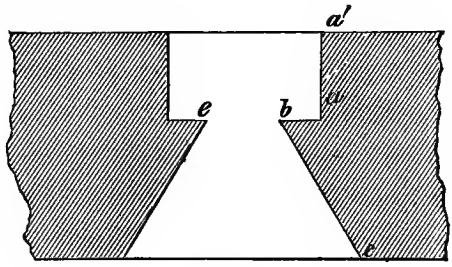


Fig. 5.

By this arrangement the opening available to the enemy's small missiles was reduced to that of the *throat*, *e b*, Fig. 5. The same effect might have been accomplished by putting the throat in the face

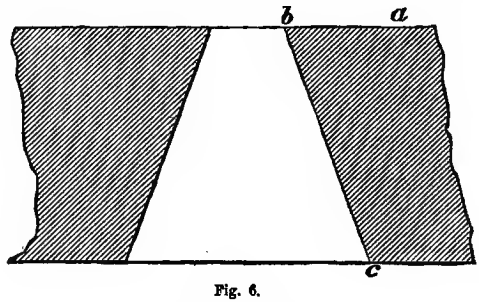


Fig. 6.

of the scarp, as in Fig. 6 (which, according to Sir Howard, would have reduced to *nothing* the "width " of the parapet"); but, for various reasons, it was found more convenient to place it 2 feet within the face.

This arrangement leaves an acute angle, *a b c*, instead of the obtuse angle of the old model, *A B C* (*vide* Fig. 4); and *here*—proceeding from this *change of form*—arose the necessity of strengthening the throat by wrought iron plates. Our experiments have proved that a solid 8-inch wrought iron throat-plate, *solidly backed against masonry*, is capable of stopping a 68-pound shot, fired at 200 yards, with no material damage to the embrasure. That, by repeated battering on the same place, the throat may not be broken through, is not pretended. The chances of such repeated hits are exceedingly small, as every sailor knows; and the structure, military or naval, perfectly invulnerable and perfectly free from danger, has not been, and never will be, invented. If that happy day arrives, men will probably give up their artificial appliances for fighting and betake themselves again to nature's weapons.

So much for the form of the American embrasure, and the objects which have controlled that form and manner of construction. Notwithstanding "the dangers of the throat being broken through," which he so earnestly deprecates, Sir Howard Douglas very inconsistently makes the half-way admission, "Perhaps the American embrasure may be "better adapted to the case for which it is designed

" than the funnel-shaped embrasure;" but immediately adds—" However this may be, it is not " adapted to, nor even practicable in, the formation " of embrasures in earthen parapets 18 feet thick." The *title*, " Casemate Embrasures," on the back of the book which describes them, might have rendered such a remark unnecessary.

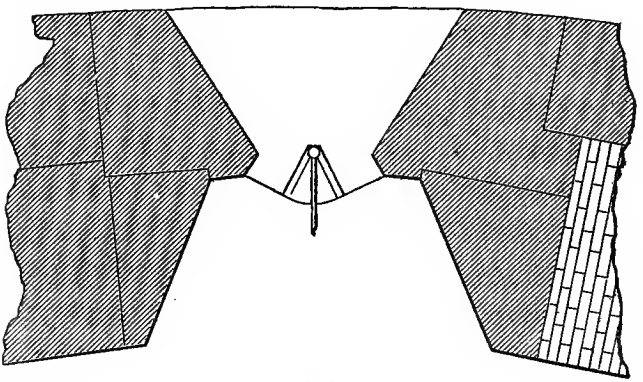


Fig. 7.

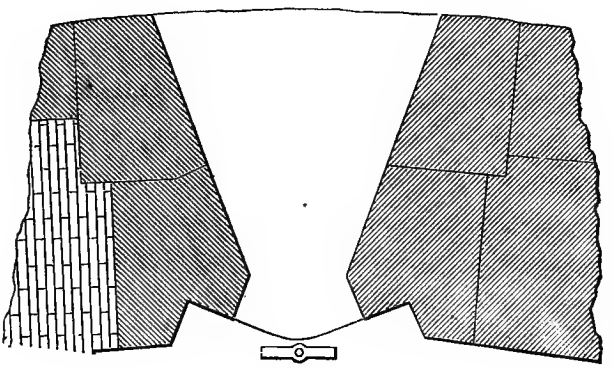


Fig. 8.

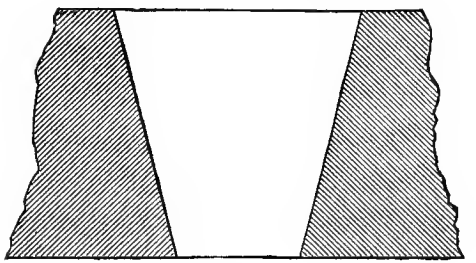


Fig. 9.

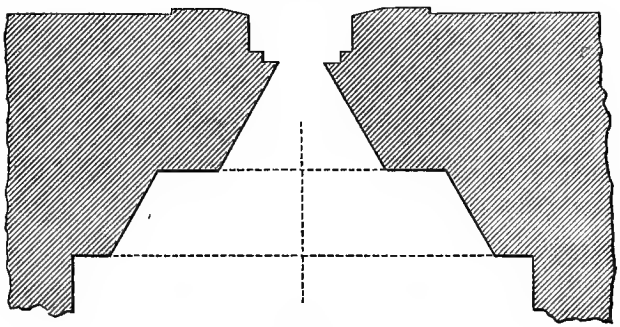


Fig. 10.

The preceding sketches are horizontal sections (drawn to the same scale) of embrasures actually constructed in recent sea-coast fortifications. Figs. 7, 8, and 9 are in European works (the prototype of No. 9 need not be sought far from London), and Fig. 10 is the new "American embrasure." The external openings of the first two are about 54 square feet; that of the third somewhat less (probably 40 or more square feet); that of the fourth, measured by the throat (for its peculiar form arrests nearly all missiles not entering the throat itself), is

$3\frac{9}{10}$ square feet. In the three former, the sharp, solid angles of masonry at the throat are liable to be broken off (even by shells, or shot of small calibres) and forced inwards upon the gunners, enlarging very much the throat (the precise danger Sir Howard compliments the American engineers with dreading). The throat of the latter cannot be broken in, unless by the long-continued hammering of an 8 or 10 inch solid shot upon the same very limited area. This embrasure is practically secure from this danger; it is practically secure against masonry fragments of any kind being carried in from the wall around; and practically secure against the fragments of projectiles which batter themselves to pieces against the cheeks of flaring embrasures.

Now, with regard to the grape and canister: but first let me quote two items of evidence taken by the "Commissioners appointed to consider the "defences of the United Kingdom." The witness is Captain B. J. Sullivan, R. N., C. B.

"Which guns do you consider most efficient— "guns in a work on the hill, which you have "just spoken of, or guns in a casemated battery "at the Warden Ledge? With raking shot, com- "ing up the Channel, both tiers, but particularly "the lower tier, of a casemated battery would be "as effective as any guns could be; but, if a ship

" attempted to engage it, then I think a casemated " battery the most defective. If a ship can bring " up against it, there is no question that a case. " mated battery should only be put where it is not " possible to put an earthen battery."

" (*Chairman.*) What are your reasons for that " conclusion? Because the casemates carry in the " shot in such a large proportion; and I believe " that if a ship brings up within 200, or 300, or " 400, or 500 yards of a casemated battery, such as " we have seen in the Baltic, the battery must be " silenced. I should have no hesitation in saying " that ships must succeed against a casemated bat- " tery, if they can get close; and it is the only " class of battery which they could succeed against " *If the embrasure were reversed*, it would increase " the power of the battery over the ship tenfold; " and then I should think that a casemated battery " would beat any ship which could be brought " against it." (Italics my own.)

" *If the embrasure were reversed*"—Captain Sullivan hit the mark exactly that time. He had seen these immense embrasures—almost large enough to drive a cart through, " in the Baltic"* (perhaps, too, *in the Channel*)—staring him in the face.

* They were equally to be seen in the Black Sea.

If a little light was shining in from the rear of the casemate, he may have seen the men moving about inside. Well might he respond, when asked *why* "a casemated battery should only be put "where it is not possible to put an earthen bat-"tery," "Because the casemates *carry in shot* in "such a large proportion." Indeed those he had seen looked as if they were made on purpose to do so. Captain Sullivan will perceive that we—Americans—have been acting on his idea to the utmost extent our materials would admit ever since we commenced making "casemated batteries," and that *now*—by the introduction of *iron* we have practically fulfilled it—we have "*reversed the* "*embrasure.*"

Let us now see the effects of this arrangement, as regards grape and canister. (I extract a few paragraphs from General Totten's report, in which the matter is treated fully.)

Suppose a hundred-gun ship to be placed within good canister range of a casemated battery of about the ship's length and height; to the 50 guns of the ship's broadside there would be opposed about 24 guns, in two tiers, in the battery. The ship would fire each gun in three minutes, or ten times in half an hour; the 50 guns would therefore make 500 discharges within that time.

With 156 balls in each 32-pdr. canister (weighing in all 31½ lbs.), there would be thrown 78,000 balls in 30 minutes. Supposing one half to miss the fort—which, considering the size of the object and the short distance, is a very large allowance—there would still remain the number of 39,000 balls to strike a surface of (say) 6,000 square feet; that is, on each square foot, 6½ balls.

Should this idea be carried still farther, as it ought, and the ship's canisters be filled with musket balls—each 32-pdr. canister holding 639 balls—the number of balls to the square foot of surface of the battery would be 26. And the comparative numbers of missiles "carried in" to the casemates by embrasures of the external area of figs. 1 and 2, and the new American embrasure, would be—

Gun 32-pdr., firing iron balls of 1.05 inch in diameter—
Through the throat of American embrasure,..... 25 balls.
Within exterior opening of European embrasure,.... 351 "
8-inch gun, firing iron balls of 1.05 inch in diameter—
Through the throat of American embrasure,..... 46 "
Within exterior opening of European embrasure..... 648 "
Gun 32-pdr., firing canisters filled with musket balls—
Through the throat of American embrasure,..... 101 "
Within exterior opening of European embrasure,....1,404 "
8-inch gun, firing canisters filled with musket balls—
Through the throat of American embrasure,..... 198 "
Within exterior opening of European embrasure,....2,754 "

By means of wrought iron *shutters*, proof against the largest grapeshot, by far the greater proportion (probably nine tenths) of the small missiles mentioned above as coming through the throat of the American embrasure *will be excluded.* Comment is unnecessary; probably no safer arrangement, by which to put a gun in battery against shipping, can be contrived than the "casemated battery" with (to borrow Captain Sullivan's happy expression) "*em-*" "*brasures reversed,*" and provided with grape-proof shutters.

The work of Sir Howard Douglas on "Naval "Gunnery" has been usually recognized as of high authority. It is in the hands of almost every naval officer, of almost every military engineer, and of almost every artillerist in the United States. It becomes, therefore, the more important to scrutinize statements which he puts forth with a confidence which seems to imply that there is no room for denial, or, at least, that irrefragable evidence for them is furnished in his work,—like the following:—

"The very worst combination of materials that "can be made in the formation and strengthening "of defensive works is that which consists of two "hard, rigid, brittle, and splintering materials— "stone and iron—acting and re-acting vehemently

"upon each other on the impact of every shot; "and which fully explains the causes of the ener- "getic vibrations, concussions, and displacements re- "ported on page 138 of General Totten's work, "inserted in Art. 434.* The combination of tim- "ber and iron is not so bad, on account of the "elasticity of the timber, by which the blow is "somewhat cushioned. A facing of earth to a "stone wall, as practiced at Sevastopol, is a far "better cover; but best of all is a parapet of "earth—good, well-rammed earth—with an escarp "wall to the rampart below."

Now, if we turn to his chapter headed "Metallic "defences to batteries" (16 pages), we do not find a solitary example of an experiment upon a "com- "bination of masonry and iron," nor a case in which masonry enters at all. If we turn to that headed "Masonry defences strengthened by a com- "bination of iron slabs" (26 pages), we find no experimental facts whatever relating to this head- ing other than three instances (paragraphs 424,

* It is worth while here to mention that the "energetic vibrations, con- "cussions, and displacements" took place in the extreme end of a bit of a wall 10 feet high, 5 feet thick, unsupported by counter-forts or other masses, and "*very much shattered*" (as General Totten states in another place) by previous firings, and that they were described rather for their scientific interest than as any example of the effect of a 128-lb. shot upon the wall of a casemated battery.

426, 427) taken from General Totten's experiments, of trifling importance in themselves (from the nature of the materials and combinations in the embrasure fired at), and totally unmeaning and misleading, detached, as they are, from the rest.

The sonorous phraseology just quoted must, therefore (like coins), be taken by its *ring*, unless, indeed, our irreverence permits us to search out evidence and form opinions for ourselves. Let us hear it again, however: "The combination of tim-" ber and iron is not so bad, on account of the " elasticity of the timber," &c., &c. Dogmatic assertion, so vague as to take no account of the meaning of the words used (*e. g.*, which includes *wrought* iron in the category of " brittle and splinter-" ing materials"), will carry no conviction without evidence, and against evidence. *Our* opinions are different.

That the 8-inch wrought iron throat-plate of our embrasure should offer an effectual resistance to heavy shot, we believe that it must be *solidly backed* by masonry. We believe that to put an " elastic material" behind the iron is to ensure its destruction (unless the thickness of iron is enormous).

Our own experiments justify this belief; so also the experiments we see recorded on detached

iron plates, and on plates attached to the sides of floating-batteries. The more unyielding and inelastic the backing, the more invulnerable is the plate. And this opinion is confirmed by more recent evidence. "We are told," says the writer on "Iron-clad ships of war," in Blackwood, "that "Armstrong's 100-pounders and the solid 68-pound-"ers lately tried on a 6-inch plated embrasure, at "Shoeburyness, *made no impression, although the* "*stroke was so violent that one projectile actually* "*recoiled back into the traverse where the committee* "*were watching for the effect;*" and the author of "Iron sides and wooden walls," in the London Quarterly, says:—"It is by no means clear that "this lining of wood in the 'Warrior,' and especially "in the French vessels, is not entirely a mistake. "It is almost certain that the buckling of the plates "and starting of the bolts, in the 'Trusty,' were "due to the elasticity of the cushion to which they "were attached. Still more clear that the success— "in the Admiralty sense of the term—of the ex-"periments at Portsmouth was owing to the "yielding of the target. A very thin plate attached "to *a granite block*, or any *unyielding substance*, "will resist almost any blow; and if two more "inches of iron were added to the thickness of the "'Warrior's' sides instead of the teak, it is more

" than probable that, with the same weight, she " would resist the impact of shot to a much greater " extent." Yet, if we are to believe the "London " Times," Mr. Whitworth acknowledges that the " Warrior," with her 20 inches of solid teak, is practically invulnerable, even to his famous " bolts."

Were there a perfectly inelastic mass of masonry behind a 5-inch plate, it would probably defy the repeated efforts of this most penetrating of projectiles, even at *ten* yards.

But we have yet missed the main point to which, after all, Sir Howard's disapproval of the American embrasure, and his unbelief in iron—particularly in that "very worst combination of " materials," masonry and iron—leads him: or more probably the point from which he started. He not only passes judgment upon the American embrasure, but upon the works which contain them. "It ap- " pears," he says, "to the author that the remedies " proposed to strengthen the casemate embrasures " is the strongest proof of the original error of hav- " ing constructed works of this description, so as to " render it absolutely imperative upon the engi- " neers of the United States to endeavor to remedy " defects inherent in masonry defences, or to replace " them by earthen works. This observation, if " followed up, would lead to a very large question,

" on which it would be out of place to enter; but " the author may refer to his work lately published " on 'Fortification,' in which that question is fully " discussed, in examining the controversy which " has long been carried on between the French and " German engineers on earthen works against ma- " sonry works,—the French engineers adhering to " the bastioned system, with parapets of earth, &c."

This indeed "would lead to a very large ques- " tion"—a question which has been thoroughly discussed (in this country, at least) in its proper bearings, viz.: "Whether masonry casemated bat- " teries are proper and eligible for *sea-coast defence*."

Our own engineer reports treat the subject in full, and I have taken my part in the discussion, so far as the affairs of the Allied fleets against the Russian casemated works throw any new light upon the subject.* It would be sufficient here to say that *in no single case* in which fleets have contended with masonry works have the results of their cannonade upon masonry walls been such as to indicate that the latter were not capable of sufficient endurance—that they were not, after the action, so little damaged as to be, to all intents and purposes, intact. Some injury was perhaps done to the masonry walls of Kinburn, but the work was "dilapidated" and

* "Dangers and Defences of New York."

almost insusceptible of defence, the guns of low calibres and in "barbette," and the attacking force overwhelming in numbers and weight of metal.

The useless cannonade of Sevastopol, October 17, 1854, produced so little effect on the most exposed work (Fort Constantine) that the Russian official accounts do not acknowledge that any damage was inflicted "other than injury to the guns "and parapet of the crown" of that fortress where the cannon and men were exposed* (*i. e.*, the barbette, *not* the casemate battery).

Bomarsund—a single "masonry casemated castle" —after it had defied a large fleet, "went down like "a pack of cards" before a small *land* battery† of 32-pounders. Yet these works, with their embrasures turned *wrong end foremost*—with external openings arranged to "carry in" the largest possible quantity of shot—with throats exhibiting acute solid angles of a brittle material—presented casemate guns under the most unfavorable circumstances in which they could be arranged in a casemated battery. Yet it was the barbette guns of Fort Constantine that appear to have suffered most, and the walls were practically uninjured.

* See 2d note to page 49, and also my account of these affairs in "Dangers and Defences," &c.; also "Naval Gunnery," par. 361.

† See note to page 49.

Open earthen batteries are excellent emplacements for sea-coast guns in certain cases, but it is rare that such favorable sites offer themselves (for example, at Sevastopol there was not a site of the kind suitable for defending the *entrance* of the harbor), and also rare that a sufficient number of guns can be accommodated on earthen batteries when they do offer themselves.

For low sites, which can be approached within grapeshot range, such batteries are *inadmissible.* Earthen embrasures in such locations furnish poor protection to the gunners against the showers of grape which may be poured upon them from ships' guns,—still less against sharp-shooting from the top-masts.* To build an artificial site in a channel-way (like that of Fort Calhoun, in Hampton Roads, or like those sites the British Commissioners pro-

* American engineers discard "earthen embrasures" for sea-coast guns (in barbette batteries) almost entirely, on account of their limiting the *traverse* of the gun to so small an angle as 30°. Captain Sullivan gives us some interesting testimony on this point, also.

"(*Sir Frederick Abbott.*) Am I to understand you that a barbette bat-
" tery would make a good fight against a ship?—Nothing, I believe, will
" contend with a ship equal to a barbette gun with raised traversing plat-
" forms. However large an embrasure may be, it can never give the sweep
" which a barbette gun can give. Wherever guns are confined in embra-
" sures, it is certain that ships can take up a position just shutting in the
" embrasures, where not a gun can fire on them, when barbette guns in the
" same position would fire on them; and it is for that reason alone that I
" think a barbette battery has an advantage over any embrasures."

pose to build for the defence of Spithead), and to put an "earthen battery" on it, would be the height of absurdity; and yet otherwise than on such artificial sites there can be no permanent defences to those waters.

This discussion—exhausted long before—need not be carried further here. When, however, an authority so high as Sir Howard Douglas alludes to this "very large question," and refers the reader to "his work, lately published, on Fortifica-" tion, in which that question is fully discussed," the latter turns to that work with no little curiosity. With a mind preoccupied with the subject of "sea-" coast defence," and the relative expediency of putting guns in "masonry casemates," or earthen batteries, he will probably be somewhat "taken " aback" to find in it nothing but a reprint of the author's views (published 40 years ago) on the Carnot system of fortification and defence by curved fires of small projectiles (comprising a repetition of that "*morceau choisi*" of all the opposers of the German system of fortification, the Woolwich experiments on the "Carnot wall"), and accounts and criticisms of the German system, taken mainly from the well-known French works of Mangin, Maurice de Sellon, &c. The reader—his mind occupied with the subjects I have mentioned, and referred to this

work for a "full discussion"—will be no less taken aback to find himself thus confronted with old acquaintances, than puzzled to imagine what (hitherto unsuspected) business they have with the matter in hand; until perchance the thought strikes him that Sir Howard, mystified, perhaps, by his German studies, has confounded the principle—older than Vauban, and certainly not disowned by the Germans (however much their works may be open to stricture for its practical violation)—that the masonry of a front of fortification should not be exposed to the besieger's *land* batteries, with the question as to the capability of *masonry sea-coast batteries* to contend with ships.* A reference to his "Naval Gunnery" might, I should think, have convinced him that there was—when a masonry work went down "like a pack of cards" before the concentrated fire of a small land battery, at 900 yards, yet resisted the "most powerful ordnance in the

* *No nation in the world* has used masonry sea-coast batteries more extensively than France—witness Cherbourg, Brest, Cette, Marseilles, Toulon (and, I presume, every other French sea-port,—not only masonry works, with walls exposed from top to bottom to naval cannonade, but casemated works, with their guns firing through masonry embrasures. The "French engineers," who, according to Sir Howard, "adhere to the bastion "system, with parapets of earth," will probably be enlightened by the discovery that the controversies as to the relative merits of the French and German systems have anything to do with this subject.

British navy," directed first from 900, then from 400 yards, without a real breach being made (although the deserted walls made *no response* to the floating structure which assailed it)—some slight *differences* of fact and argument to be used in the treatment of these two subjects. However that may be, it is the first time that we, on this side of the water—though tolerably well acquainted with the "German system"—have ever suspected that the works that Sir Howard has anglicized contained a "full discussion," or any discussion at all, of the proper kind of constructions for SEA-COAST DEFENCE, or, indeed, had the slightest connection with the subject.

[Postscriptum.]

Since the above pages were placed in the printer's hands, I have seen Sir Howard Douglas's "Postscript to the section on Iron Defences, con-"tained in the 5th edition of the Naval Gunnery, "in answer to the erroneous principles set forth by "the Reviewer in the Quarterly Review, for Octo-"ber, 1860."

The question of "Iron sides *versus* wooden "walls" is not one which I am competent, professionally, to discuss. In the preceding pages I have indicated perhaps sufficiently my concurrence with those naval authorities who believe that to some more perfect protection against modern projectiles the course of things must inevitably tend, and that iron will probably be the material through which this protection will be gained. But it is quite sufficient for me, as an engineer, to take the facts as I find them: that iron floating-batteries have actually been constructed expressly for the attack of fortifications, and that they are regarded by high naval authorities as among the established means of such attack; that both France and England are actually

constructing iron ships of war; and that there are those who vaunt the ability of such ships to "engage, at breaching distance, any land battery." Expressing my entire disbelief in this opinion, it is none the less proper that those who have to design or construct land batteries should have a full anticipation of what their works will or *may probably* have to contend with; and to show that they will not be found wanting against such probable tests.*

In this "Postscript," however, Sir Howard has, in two places, reiterated his erroneous assertions as to the embrasure experiments in the United States, in reference to which I have attempted to prove that he does not only not at all understand the system which he condemns, but that he has not even "attentively read" the report of General Totten, on which he bases his opinions. As previously stated (in the text), more than five hundred *new* embrasures on General Totten's system have been built, within the last four or five years, in fortifications in course of construction. On what real basis, then, rests the claim to "authority" (which Sir Howard tells us is conceded to "Naval Gunnery" all the

* It is proper here to remark that guns of "extraordinary" calibre were urged by the Engineer Department of the United States, for the purposes of sea-coast defence, long before iron-clad floating-batteries or ships were thought of.

world over) of the work which uses language like the following,—and that, too, with General Totten's Report before him, and without a word of conflicting evidence from any other quarter:— * * "The "prophecy of General Totten is not on the eve of "fulfillment; for his proposition to combine iron "with masonry, to defend the throats of casemate "embrasures in masonry defences, had been tried, "was not successful, and never will be fulfilled; for "the very worst combination that can be made of "materials for defensive purposes is that of stone "and iron, which, from their rigid, brittle qualities, "act vehemently on each other, and shake the whole "fabric so formed." What claim to be considered a careful, accurate, and candid sifter of facts, can the writer have who, with General Totten's report before him, announcing, in its concluding paragraph, the approval, by the American War Department, of his system, has asserted, in this authoritative manner, the *disapproval* of that Department—(the very curious manner in which Sir Howard discovers the decision of the Department in two paragraphs of my letter to the Secretary of War is alluded to in the text)—and who, while continually reiterating his favorite phrase, "*the very worst combination* that "can be made of materials," &c., &c., fails to support this opinion by one single experimental fact as to

the combination of stone and iron (for those two or three cases of "firings," taken from General Totten's report, detached from the rest, have not the slightest significance), and who calls wrought iron a "brittle and splintering material?"

There is one other matter in the Postscript on which I would say a few words, as it has some relation to the value of guns in casemates, viz., the greater damage done to the vessels of the detached squadron at Sevastopol by the guns of the "Wasp" battery (1,200 yards distant) over that inflicted by those of Fort Constantine (700 or 800 yards distant), with which the squadron was immediately engaged. Sir Howard makes allusion to it as follows:—

"In the letter signed 'A Captain, R. N.,' which "recently appeared in the 'Times,' the writer "appears to think that he has decisively settled the "question in favor of iron-sided ships by stating "that the severe damage sustained by the British "fleet in the bombardment of Sevastopol, on the "17th of October, 1854, would have been prevented "had the sides of our line-of-battle ships been pro-"tected by iron plates. But the 'Captain, R. N.,' "who says he served there, seems not rightly to "understand the case. The fire which did such "damage to the British ships, and from which they

" were forced to withdraw, was not horizontal fire,
" but plunging, direct fire, from the Wasp and
" Telegraph batteries, placed on the summit of the
" cliff, and against which those ships could not have
" been protected unless their *decks* had been covered
" with shot-proof iron plates. According to this
" very erroneous conclusion, published on the
" authority of an officer—present, as he states, at
" that affair—we see how it has been run away
" with, and carried to the credit of iron-sided
" ships."

Whether "A Captain, R. N.," who "served
" there," was able to "understand the case," or not,
I cannot say; but "A Captain, R. N.," who served
there *on the Agamemnon*, *ought* to understand it.
Hear Captain Cowper P. Coles' evidence ("Evidence
" taken before the Commissioners, &c.") :—

" 397. (*Chairman.*) Have you any idea what
" was the nature of the guns which they fired at
" you?—The Russian 32-pounders, which, I think,
" are a trifle larger than ours."

" 398. (*Sir Frederick Abbott.*) Were those the
" largest?—Those at the Wasp Fort, I imagine, were
" 68-pounders."

* * * * * *

" 439. (*Sir Frederick Abbott.*) You have stated
" that the fire from the Wasp Fort was more

" destructive, or annoying, than that from any other " fort; will you explain why?—I fancy that they " could see better through the smoke, from having " no embrasures (I would here wish to remark that " embrasures in casemated forts, when once filled up " with smoke, obscure the sight), and, being high " up, they were less molested by the fire of the " ships, to a certain extent; but I also imagine that " they had superior gunners in Wasp Fort, for it " was hardly ever known to make a bad shot."

" 441. (*Sir Frederick Abbott.*) Then the advant- " age was not at all connected with the direction " of the shot,—that is to say, its coming down from " a greater height upon your decks?—No; the angle " would be so little that I do not think that it " made any great difference; but it was also in a " raking position, as Wasp Fort was on our " quarter."

* * * * * *

" 450. (*Chairman.*) Do you think that if the " Wasp Battery had been higher or lower its fire " would have been more effective?—If lower, they " could have laid their guns with more precision; " they could have taken better shots; but being " high enabled them to have a better view of the " ships over the smoke."

And Commander Dahlgren, U. S. N., speaks as follows:—

"The value of the small works on the cape and "bluffs was clearly defined in these results; being "above the dense cloud of smoke that enveloped "the ships and the lower forts, their aim was not "embarrassed; while the seamen labored under the "difficulty of firing, with an inconvenient elevation, "at objects that they saw but seldom, and then but "dimly and briefly."

Command, in a shore battery, has, doubtless, its advantages, where it can be attained (which is far from being usually the case). But batteries "*à fleur d'eau*" have also their advantages; and, for the great majority of cases, no command can be attained except by piling guns in triple and quadruple tiers in casemates. The actual plunging effect, so strongly insisted upon by Sir Howard, is very trifling from batteries even as high as 120 or 150 feet, beyond 600 or 800 yards; and the ricochet of such batteries is lost. Captain Coles points out very clearly the advantages of the Wasp battery,—viz., larger-calibred guns, better gunners, a clearer view over the smoke, greater difficulty in hitting the battery from the ships, &c., &c. The plunging effect (as due to *command*) of a battery 130 feet high, upon ships 1,200 yards distant, amounts to nothing. The

angle which a line, drawn from the deck of the ship to the battery, would make with the horizontal, would be about 2°. The angle of descent of the shot would be somewhat greater. If the battery were "*à fleur d'eau*," the elevation of the gun necessary for the range would be about 2°; and the descending shot would make an angle, probably, fully equal to what it would make in the other case.

I have stated already that casemate guns could not be exhibited under more disadvantageous circumstances than they were in those Russian works. Embrasures of enormous dimensions, with sharp angles of masonry at their throats, are not combinations under which American engineers advocate the advantages of casemated batteries. Add to these disadvantages the low calibre of the guns, and the fact that a wooden fleet was not destroyed (three of the five vessels originally engaged were driven off crippled, so also the "Queen," which came to their aid, soon after she got into her position), is intelligible. The "Agamemnon" received 240 shots or shells (Captain Coles mentions but *three* shells, "one "which burst on the main deck, and two in the "bunt of the main-yard"); had she received but *half a dozen* shells and solid shot of sufficient calibres, she would probably have been disabled. In writing on this subject once before, I stated (and I

believe the facts justify the statement) "that it is "only due to the inefficiency" (in respect to *calibre*) "of the projectiles by which she was struck that "she was not destroyed."

In conclusion, I would state that the defence of the American system of sea-coast fortifications against the strictures of Sir Howard Douglas has been with me no labor of love. Much more grateful would it have been to have had only to reciprocate the expressions of regard and professional respect which he uses in speaking not only of American naval officers, but of American engineers. I hesitated long, after the appearance of the 5th edition of his "Naval Gunnery," to undertake this work. My first impulse was to address Sir Howard a private letter, asking a correction of errors of statement, and the giving of a just view of what the American embrasure and the American system of casemated works actually were. Those who have read these pages will, I think, concur with me in the opinion that that course would have been quite insufficient. The "Naval Gunnery" is widely received as of the highest authority, being (according to his own statements) translated into several European languages.

American engineers have a right to claim that their works shall not be condemned in it without

proper information or understanding of them; and, if noticed at all, that it shall be in a manner which does not betray such complete want of accurate information and such a readiness to overlook the actual facts, or to find in them only what will sanction what appear to be the prejudgments of the author on matters which have now assumed a high importance and which have been dragged into the arena of controversy.

ERRATA.

Page 28, *note*, 5th line, for "she," read "they."

Page 55, 2d line, for "rotary," read "rotation."

Page 89, line 15, instead of "figs. 1 and 2," read "figs. 7 and 8."

Page 94, 17th line, for "embrasure," read "embrasures."

NOTE TO PAGE 99.—The author's language may be excepted to as doing injustice to Sir Howard's meaning. It may be alleged that his argument from the German system rests simply upon his assumed proof of the impropriety of placing guns in casemates, behind masonry walls, as practiced for *flanking purposes* in that system. It matters little, however, as to *my* argument.

The reliance upon "casemated caponnière defences," for purposes vital to the security of a place (*i. e.*, for the flanking defence), upon which may be concentrated the curved fire of the besieger's batteries, from the second parallel, or the direct fire of his counter-batteries, from the crest of the covert-way, is so entirely different a matter from the use of guns in casemates for SEA-COAST DEFENCE, that the reader of his work may well be excused for mistaking what the pith of his "full discussion" consists in.